VOLUME 28 TJ1 .A72 NUMBER 7

NEXT MONTHLY MEETING, MARCH 21, 1907

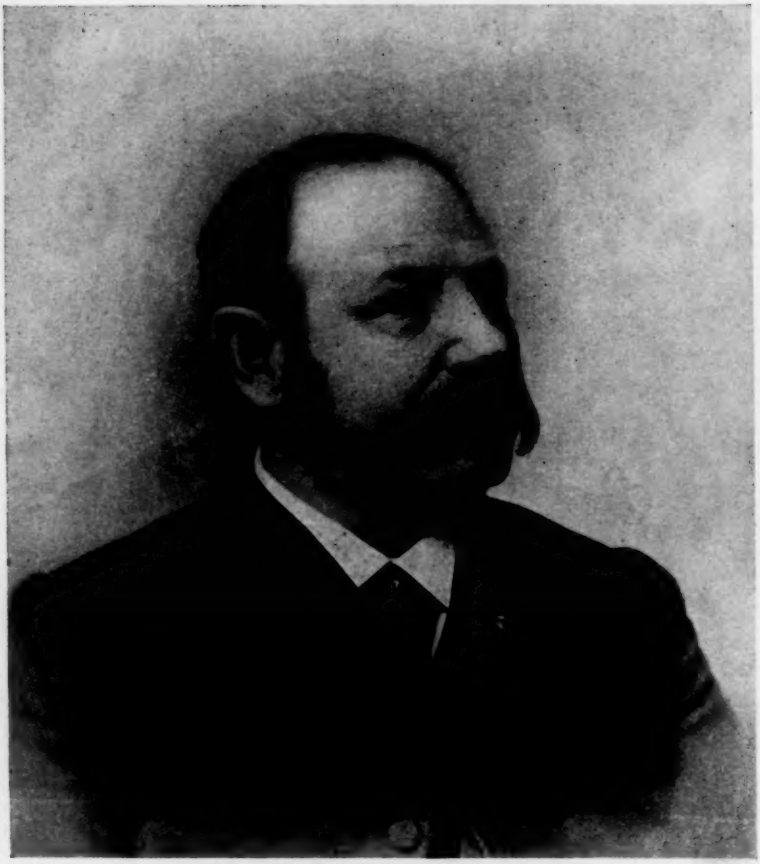
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

PROCEEDINGS

MARCH, 1907

CONTENTS

INDIANAPOLIS MEETING, MAY 28-31, 1907



ADMIRAL CHARLES HARDING LORING

A tribute to Admiral Loring was written, at the invitation of the Council, by Mr. Walter M. McFarland, Vice-President of the Society. (See page 1153)

MARCH, 1907 VOL. 28. No. 7

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

PROCEEDINGS

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
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The professional papers contained in Proceedings are published prior to the meetings at which they are to be presented, in order to afford members an opportunity to prepare any discussion which they may wish to present. They are issued to the members in confidence, and with the understanding that they are not to be published even in abstract, until after they have been presented at a meeting. All papers are subject to revision.

The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

Proceedings is published twelve times a year, monthly except in July and August, semi-monthly in October and November.

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PROCEEDINGS

OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

VOL. 28 MARCH, 1907 NUMBER 7

AN address by Mr. J. W. Lieb, Jr., Vice-President of the Society, on "Vesuvius and Pompeii" will be delivered in the large auditorium of the Engineering Societies Building, Thursday evening, March 21, at 8.15 o'clock.

The lecture will be illustrated by lantern slides from original photographs taken by Mr. F. A. Perret who was in the Vesuvian Observatory during the last eruption and from photographs taken by the lecturer during a visit to Vesuvius and Pompeii shortly after the eruption. A series of lantern slides showing the state of the Mechanic Arts in Pompeii have been especially prepared for the lecture.

Through the courtesy of Mr. E. Burton Holmes, the well known Travelogue author, a series of original moving pictures of Vesuvius in eruption and of a flowing stream of lava will be shown by Mr. Oscar B. Depue.

Ladies will be especially welcome at this meeting and will doubtless find the lecture of unusual interest.

DEDICATION

The dedication of the building of the Engineering Societies will be an extraordinary event. The first part of the week, April 16 and 17, will be devoted to the formal exercises of dedication. In the latter part of the week professional sessions will be conducted by the Founder Societies.

The professional session for which our Society is responsible will be held on Thursday evening, when we will be addressed by Brigadier

General William Crozier, Chief of Ordnance, and by Brigadier General Arthur Murray, Chief of Artillery, United States Navy.

These addresses are in keeping with the visit of the Society to Fort Hancock and the Sandy Hook Proving Ground at the time of the December Meeting, and will treat of the War Department of the United States as an engineering organization, and of the engineering problems connected with coast defense.

The dedication ceremonies will take place on Tuesday afternoon, April 16, and a reception will be held in the evening.

On the afternoon of Wednesday, April 17, Founders' Day, there will be a joint meeting of the three Societies at which there will be addresses by the Presidents of the Societies, and greetings from sister societies and institutions from all over the world.

Wednesday evening is at present unassigned, to admit of private functions for the many distinguished guests who will be in the city at this time.

On Thursday and Friday afternoon, there will be professional sessions by the Founder Societies, and on Friday evening, possibly a "smoker," which will conclude the exercises of the week.

Throughout the week there will be opportunities for visits to various establishments of engineering interest, as is customary with the meetings of the Society.

The entire function will be an extraordinary one in the history of engineering, and every one should make an extra effort to be present. Detail announcements will be sent later.

THE INDIANAPOLIS MEETING

Two sessions of the Indianapolis Meeting have already been determined; one for the different phases of Automobile engineering, for which several authors who have made important investigations of its problems have been secured, and the other will be devoted to Superheated Steam.

Papers on several features of this problem are in hand, and among them, complete determinations of specific heat of superheated steam showing new values from those which have heretofore been accepted as standard.

Whereas these two important sessions should be as complete as possible, yet unless authors immediately notify the Society of their intention to contribute, we may not be able to provide space for the papers received at the last moment.

Further, it has been customary in the past, when no regular publication was provided, to receive papers almost to the day before the

meeting. With the present improved methods, whereby members receive every paper in advance and bound in regular form, no such papers can be assured of presentation if received after the middle of the month preceding the meeting. If the Meetings Committee have completed their program earlier, then no more papers can be received for that particular session or meeting.

No further notice will be given.

THE FEBRUARY MEETING

Prof. Charles M. Allen, Professor of Experimental Engineering, Worcester Polytechnic Institute, Worcester, Mass., addressed the Society at the regular monthly meeting, February 12th, on the subject of gasolene.

The meeting was held in the large auditorium of the Engineering Societies Building. A feature of the attendance was the large number of young men. This was no doubt in response to the efforts of the Meetings Committee to encourage the attendance of the younger members. The speaker treated of many of the common uses of gasolene, alcohol, and coal oil, with special reference to the method of handling these fluids in automobile work. Professor Allen left no one in the audience in doubt as to his intimate acquaintance with the properties of the three fluids and especially with their detonating power. The series of experiments were most interesting.

Invitations to attend this meeting were sent to the local representatives interested in the manufacture of automobiles.

THE THIRTY-FIRST STREET HOUSE

The ho se at 12 West 31st Street, which has been the home of the Society for several years, is closed. The property has been sold, and the proceeds will take care of one half the obligation which the Society assumed for the purchase of the land upon which the building of the Engineering Societies was erected.

THE LIBRARY

The library has been moved into the spacious rooms on the twelfth and thirteenth floors of the new building set apart for the use of the libraries of the Founder Societies. The facilities for research among the works on engineering have been greatly increased by the union of the three libraries. The entire sets of Transactions of the national societies of America and Europe; complete issues of technical maga-

zines; the many volumes of books on engineering in its different phases by recognized authorities make the new library a source of valuable information to the practical engineer and to the student.

INDUSTRIAL ENGINEERING

Attention of the members cannot too often be called to the many branches of engineering covered by the American Society of Mechanical Engineers. Its constitution is the broadest and most inclusive of any of the national engineering societies.

Industrial engineering, now so generally recognized as an essential to intelligent management of any business, is distinctly specified by the Society, and work, either in planning or management of important industrial operations is to be regarded as a branch of engineering, and as such forms a basis of qualification for admission to the grade of member.

Members are cordially urged to interest friends in joining the Society. The office will send application blanks to any who make requests for them.

THE NATIONAL FIRE PROTECTION ASSOCIATION

The Committee on Automatic Sprinklers of the National Fire Protection Association of Philadelphia are receiving many inquiries regarding the rule Sec. F, No. 8, Fittings—"Long Bend Fittings are recommended." It appears that long bend fittings are not made now for the small sized pipes and the sprinkler equipment companies wish to abandon the use of long bend fittings in the large sizes.

The Committee desires information whether the requirement of long bend fittings is insisted upon in any locality, and if so the sizes and types of fittings which are required to be of long bend pattern. They also wish to receive whatever friction loss statistics are available, as these probably are used as basis and ground for such a requirement. The Secretary of the Society will be pleased to forward to the National Fire Protection Association all the replies that may be addressed to him. The A. S. M. E. are members of the N. F. P. A.

THE JAMESTOWN EXPOSITION

The Secretary would be glad to be advised of members who expect to attend the Jamestown Exposition, as the Society would benefit from reports of the most important engineering work on exhibition there. Members who are planning to attend would render valuable aid by corresponding with the Secretary, with a view to preparing reports of the progress of that branch of engineering in which they are especially interested.

MARCH MEETING

Attention is called to the change of date of the March meeting from the second Tuesday in the month to Thursday, March 21, which was caused by delay beyond the control of the author in securing the apparatus for the motion pictures.

No pains have been spared by the lecturer to make the evening the most delightful possible for the Society, and ladies will be especially welcome.

LIFE MEMBERSHIP

On the occasion of the regular meeting of the Mechanical Engineering Department, the alumni and students of Lehigh University presented a life membership in The American Society of Mechanical Engineers to Professor Joseph F. Klein, in honor of the twenty-fifth anniversary of his service at Lehigh.

The presentation was made by Prof. R. C. H. Heck, and was followed by the presentation of the Loving Cup by Mr. Harry T. Morris, Superintendent of the Armor Department of the Bethlehem Steel Co., and Mr. J. Harrigan.

Mr. Robert M. Bird, Superintendent of the Treatment Department of the Bethlehem Steel Co., presented a gold watch with an address in which he gave a résumé of Professor Klein's work at the University since 1881.

Several papers were read by undergraduates, the first of which was on the subject of "Industrial Betterment," by Mr. John A. Brodhead.

Mr. Albert Mayer, followed with a description of the "High Pressure Water System of Philadelphia." Mr. George H. Blakeley, Superintendent of Construction for the Bethlehem Steel Co., gave an informal talk on the new Saucon Plant of his company. This address, however, is of such scientific and mechanical interest that the Society has arranged with Mr. Blakeley to give a paper before the May Meeting in Indianapolis.

More than one hundred and fifty alumni and undergraduate mechanical engineers were present. The Society was represented on this occasion by the Secretary.

OBITUARY

HOBART CANFIELD

Hobart Canfield was born in 1841 in Morristown, N. J. He was educated in the schools of that city and began his apprenticeship with the Speedwell Iron Works, continuing with the Canfield & Lidgerwood Machine Shop until 1859. His shop experience was gained with the above named company and in erecting marine engines with the Novelty Iron Works, New York.

From 1860 to 1865 he erected sugar, coffee, and cotton machinery, and from 1868 to 1872 was with the Pacific Mail Co. leaving them to accept a position on dry dock work at the Mare Island Navy Yard, and remaining there until 1876. He became associated with the Pennsylvania Railroad Company as master mechanic of their Hoboken shops in 1877, and held this position to the time of his death, November 15, 1906, directing the operations of the shop which is employed on the maintenance and repairs of the entire floating equipment used by the Pennsylvania Railroad Company in the New York harbor. During this period, Mr. Canfield inaugurated many improvements in shop methods and developed a great many features that adapt the equipment to the peculiarities of harbor transportation.

He was widely known among the marine interests in New York harbor, and highly respected for his professional attainments.

He was elected a member of the Society in 1892.

VERNON H. ROOD

Vernon H. Rood was born in Elyria, Ohio, Nov. 10, 1856, and died in Bad Manheim, Germany, Sept. 2, 1905. He graduated at Stevens Institute of Technology with the Class of '82, and shortly afterward accepted a position as assistant to the superintendent of J. C. Haydon & Co., builders of mining machinery at Jeanesville, Pa. From 1882 to 1884 he was draftsman with Coxe Bros. & Co., at Drifton, and occupied a similar position with the Philadelphia and Reading Coal & Iron Co., at Pottsville from 1884 to 1887. In 1887 he became associated with the Barr Pumping Engine Co. of Philadelphia, remaining with them until 1890, when he was made vice-president and

manager of the Jeanesville Iron Co., Hazelton, Pa., and held this position until his death.

Mr. Rood became a member of the Society in 1886.

FRANCIS RAMSEY ALLEN

Francis Ramsey Allen was born in 1881 in Summit, N. J. He was educated at the Adelphi Polytechnic in Brooklyn and at the Black Hall School in Connecticut, at which place he continued his college preparatory studies and was graduated from Sibley College, Cornell, in 1904, with degree of M.E.

Mr. Allen gained his shop experience with Washburn & Moen, Worcester, the Locomotive Repair Shops, Keene, N. H., and Bethlehem Steel Co., Bethlehem, Pa.

He accepted a position with the Niles-Bement Pond Co. and was located at their works in Philadelphia and later in Plainfield, N. J. He was transferred to the Pratt & Whitney branch of the same company at Hartford, Conn., and finally to the general sales force of this company at 111 Broadway, New York.

He was a member of the Sigma Phi fraternity, and was active in college life at Ithaca. Mr. Allen died in Brooklyn, December 15, 1906.

CARLETON WALWORTH NASON

Carleton Walworth Nason was born in 1849 in Woburn, Mass. He was educated in the New York schools and Columbia School of Mines. He entered business life early, and in 1872 became vice-president of The Nason Mfg. Co., and took entire charge of the business in 1884.

Mr. Nason advanced the art of steam heating and steam fitting by many important inventions. Among these were the pneumatic lift and the sheet iron diaphragm of a radiator, running almost the length of the tube, the design now used largely by the U. S. Navy. Mr. Nason also designed a wrought iron boiler for house heating, which is notable for its high efficiency. He patented few of his inventions.

In 1884 Mr. Nason was Chairman of a Committee representing this Society which worked in conjunction with representatives of manufacturers and contractors for the adoption of a schedule of standard flanges for pressures up to 200 pounds and for pipe sizes from 2 to 48 inches. For many years he served on the Committee of the General Institute of Mechanics and Tradesmen.

Mr. Nason became a member of the Society in 1880, and served as Manager on the Council 1889–1892. He was President of the

Motor Cycle Club, a member of New York and Atlantic Yacht Clubs and Eastport County Club. He died November 4, 1906.

EDWARD THOMAS HANNAM

Edward Thomas Hannam was born February 16, 1861, at Baltimore, Md. He was educated in the public schools at Baltimore and served his apprenticeship in the Mt. Clare Shops of the B. & O. R. R., becoming in 1883 chief draftsman of the Trans-Ohio Division. In 1885 he accepted a position in the drafting room of the Barney & Smith Car Works at East Buffalo, N. Y. From 1887 to 1906, he occupied positions as mechanical engineer with the Cumberland & Pennsylvania R. R., Mt. Savage, Md., superintendent of the Kingsland & Douglas Mfg. Co., St. Louis, Mo., mechanical engineer and draftsman for Meier & Foster, and the Heine Boiler Co., St. Louis, Mo., mechanical engineer and agent for the Hawley Down Draft Furnace Co. of Chicago, Ill., and secretary and general manager of the Ohio Territory of the same company. He became manager of the Cincinnati District for the Erie City Iron Works in 1901, and was associated with the Atlas Engine Works in 1904.

Mr. Hannam invented the Atlas water tube boiler, and superintendent its building until June, 1905, when he was appointed manager of the Philadelphia District of the Atlas Engine Works, and remained in this position until 1906, when he became manager of sales of the water tube boiler department of the same works, which position he held until his death, August 18, 1906, at Chicago, Ill.

GEORGE FREDERICK STILLMAN

George Frederick Stillman was born April 11, 1858. He was educated in the public schools and at Cazenovia Seminary, and gained his shop experience at the works of E. Remington & Sons; Saginaw Mills and Ship Yard. He was assistant to Prof. Charles I. King, University of Wisconsin, and superintendent of The Lake City Tool Company. He returned later to E. Remington & Sons to the department of model and tool making. He became superintendent of shops of Smith & Weston of Syracuse and later entered the employ of The Smith Premier Typewriter Company as tool maker and was made superintendent of the factory. He was thoroughly familiar with not only the machine part of the business, but invented many details of the machine and devised ways and means to reduce the cost of production. He made several inventions outside of his improvements on the typewriter, one of these being a measuring machine, in which he introduced an ingenious method of correcting

the pitch of the master screw. He was also one of the inventors of the clincher type of bicycle tire, which eventually came out as the Dunlap type.

Mr. Stillman became a member of the Society in 1904. He died December 2, 1906.

CHARLES ADDISON BRAGG

Charles Addison Bragg was born in St. Louis, Mo., in 1850, and received his early education in St. Louis schools, graduating at the Union High School of that city. He prepared for college at Stamford Institute, Stamford, Conn., and subsequently attended Yale University.

Mr. Bragg did his first shop work in St. Louis and Philadelphia with the Globe Shot Co., with whom he later became manager and superintendent. He was the inventor and patentee of the method of manufacturing shot by which the shot instead of being dropped through the air dropped through a jet of steam which afforded a more rapid rate of cooling and reduced very materially the height of the shot tower.

He became associated as constructor and salesman with the United States Electric Lighting Co. in 1882, and was one of the pioneers in electrical work. In 1889 he became connected with the Westinghouse Electric and Manufacturing Co. as manager of the Philadelphia office, and held this position to the time of his death, July 29, 1906. He was a member both of this Society and of the American Institute of Electrical Engineers, and took an active interest in mechanical and electrical affairs.

WILLIAM CHRISTOPHER TURNER

William Christopher Turner was born in Philadelphia, Pa., 1856, and educated in public and private schools in that city. He became general manager and superintendent of the Delaware and Chesapeake Improvement Co. of Philadelphia, remaining with them six years. He was for some time with the Link Belt Engineering Co. and later became associated with the C. W. Hunt Co. and the Caslin Machine Co. of New York. He accepted a position with the Babcock & Wilcox Company, representing them in the South, and later became supervisor of the machine boiler department. In 1904 Mr. Turner was one of the organizers and vice-presidents of the Daldt Steel Co. of New Castle, Del., and was an officer of this corporation until the time of his death July, 1906.

Mr. Turner became a member of the Society in 1881.

WALLACE C. JOHNSON

Wallace C. Johnson was born in 1859 in Granville, Mass. He graduated from Williams College in 1882 with the degree of M.A., and took a post graduate course at Worcester Polytechnic Institute, receiving in 1884 the degree of B.S. His professional career began as assistant engineer hydraulic department, Holyoke Water and Power Co., and he subsequently occupied the following positions: Chief Engineer, Niagara Falls Hydraulic Power and Mfg. Co. 1886–1900; 1900–1905, Chief Engineer, Shawinigan Water and Power Co., Montreal Can.; 1905–1906 Chief Engineer, Bodwell Water Power Co., constructing a hydro-electric plant on the Penobscot River at Old Town, Me. Since 1884 he has made many examinations and reports upon hydro-electric propositions in different parts of the country.

Mr. Johnson was a member of the State Water Supply Commission of New York, President Shawinigan Terminal Railway, Vice-President Albion Power Co., director Laval Electric Co., consulting engineer Niagara Falls Hydraulic Power and Mfg. Co., Shawinigan Water and Power Co., Hannawa Falls Water Power Co., Pittsburg Reduction Co., Milford Construction Co., Buxton Power Co.

He was a member of the American Society of Civil Engineers, Canadian Society of Civil Engineers, American Institute of Electrical Engineers, Past President Engineers' Society of Western New York, member of the Society of Arts (London), St. James Club (Montreal), University Club (Buffalo).

EMPLOYMENT BULLETIN

The Society has always considered it a special obligation and pleasant duty to be the medium of securing better positions for its members. The Secretary gives this his personal attention and is most anxious to receive requests both as to positions and as to men available. Notices are not repeated except upon special request. Copy for notices in this Bulletin should be received before the 20th of the month. The list of men available is made up entirely of members of the Society and these are on file, with the names of other good men, not members of the Society, capable of filling responsible positions, information about whom will be sent upon application.

POSITIONS AVAILABLE

019 Salesman for condensers wanted by a Pennsylvania concern.

020 Designer on jigs and tools. New Jersey company.

021 Young man as designer and draftsman who will work up into position of responsibility. Location, Connecticut.

022 Draftsman with thorough knowledge of construction and detail work. Location, Canada.

023 General Manager for boiler works in eastern city. Preferably a man with some experience in similar lines. Must be a good executive and sales manager.

024 Young man desired as assistant to engineer for large water company in middle west. Technical training and practical experience in field and power plant construction or operation necessary.

025 Chief Engineer for pumping station. Must have had considerable experience and capable of handling and superintending repairs on large triple-expansion pumping engines. Pleasant location. Engineer's residence on property.

026 Mechanical Superintendent for manufacture of power milling machines. Successful experience in handling two or three hundred men, including ordinary machinists, draftsmen, designers, and pattern makers, competent to choose the best machine tools and efficient men, and to execute a contract. Prefer a man between thirty and forty, good executive ability and able to assume responsibility and make good. Location, Middle West.

MEN AVAILABLE

36 Mechanical engineer, seven years' experience in machine shops and installation of heavy machinery; three years instructor in trade

school and for past six years dean of a college of mechanical engineering, desires to make a change. Prefers position similar to present or as president or superintendent of a trade school.

37 Practical machinist, technical graduate, 33 years old, at present and for past five years in charge of design and perfecting special machinery in works employing 5000 men; previous experience in gas engine, refrigerating machinery, and rolling mill. Wants connection with engineering firm or works with opportunity to grow, which present position conditions do not offer.

38 Sales engineer, Cornell 1903; desires position as salesman with firm desiring to establish agency in Ohio.

39 Technical graduate, practical, and executive experience, now in full charge of mechanical department of a college, desires change of location. Successful in development of college courses in practical lines where commercial production is an object.

40 Graduate mechanical engineer with valuable mechanical and electrical experience in shop, office and laboratory, now holding responsible position in public service, desires to connect with a manufacturing or contracting concern.

41 Member, 32, desires position as superintendent or assistant superintendent of manufacturing plant or charge of installation and operation of machinery in factory. Experienced in handling all classes of mechanics and laborers. Wide experience in engine and boiler practice, transmission machinery, and general factory equipment.

42 M. E., Cornell, six years' experience in general engineering work, including shop experience, drawing room, and executive work. Desires position with engine or contracting company.

43 Business mechanical engineer, thirteen years consulting engineer and trouble man for large manufacturers. Expert in use of steam for power and manufacturing purposes. European experience in labor, materials, agents and selling.

44 Technical graduate, 25 years old, three years' experience in office, and handling men in engineering and manufacturing plant, desires position with manufacturing or contracting concern.

45 Associate member, chief draftsman with experience in the design of gasolene engines for cars, trucks and other vehicles, desires position as mechanical engineer or assistant superintendent in the same line of work. Technical graduate, six and one-half years' experience.

46 Mechanical engineer engaged in teaching in a technical college of the first rank, desires a position in practice during the summer vacation of 1907. Good experience in executive work, including the handling of men; engineering calculation and design; testing and

experimental work; inspection of machinery and engineers' tools, stores and supplies. Power plant work a specialty.

47 Electrical engineer, technical graduate, nine years' experience in large electrical manufacturing companies, in testing, designing and engineering work.

48 Mechanical and electrical engineer; age 30; technical graduate; 12 years' practical experience, desires change of position as assistant to chief engineer, superintendent, manager, or similar position. Location, preferably Philadelphia or vicinity.

CHANGES OF ADDRESS.

ADAMSON, Cecil F. (Junior, 1906), Mech. and Elec. Engr., Hamilton Bldg., Akron, Ohio.

ANDERSON, Leslie Douglass (Associate, 1906), United States Smelting, Refining & Mining Co., 531 Dooly Block, Salt Lake City, Utah.

APPLETON, Wm. Day (Junior, 1905), Apartado 23, Zamora, Michoacan, Mexico.

AUSTIN, William F. (1905), Asst. Supt., Eddystone Plant, Belmont Iron Works, Eddystone, Pa.

BALDWIN, Stephen W. (1880), Mech. Engr., 29 Hyslop Road, Brookline, Mass.

BERTSCH, John Charles (1901), Refrigerating Engr., 16 Orange St., Macon, Ga.

BROWN, John J. (1902), Genl. Western Sales Mgr., International Steam Pump Co., 770 Old Colony Bldg., Chicago, Ill.

BRUSH, Frederick Farnsworth, (Junior, 1900), Brush & Allen, Engrs., 1331–32 Penobscot Bldg., Detroit, Mich.

BUCKLEY, John Francis, (1906), Fairbanks, Morse & Co., and *for mail*, 4 Cottage Lawn, Beloit, Wis.

BUSHNELL, Fred. N. (1891), Stone & Webster Eng'g Corp., 84 State St., Boston, Mass.

CATLIN, William Lyle (Junior, 1906), Supt., Chattanooga Machinery Co., Chattanooga, Tenn.

COMSTOCK, Charles Warren (Associate, 1906), Comstock Jones & Co., 407–409 Caxton Bldg., Cleveland, O.

CROSBY, William Wyman (1900; 1902), M. E., Asst. to F. W. Dean, 53 State St., Boston, Mass.

DAVIS, Herbert Rowan (Junior, 1901), care of Hope Engineering & Supply Co., Joplin, Mo.

DUERNER, Henry L. Jr. (1901), Mech. Engr., 78 Tacoma St., Rochester, N. Y.

ENGEL, Louis G. (1887), care of C. Von Goeben & Engel, Engrs. & Contrs., 114 Liberty St., New York, and *for mail*, Standish Arms, 169 Columbia Heights, Brooklyn, N. Y.

GABRIEL, Charles R. (1901), Designing Engr., E. W. Bliss Co., and *for mail*, 1810 Glenwood Road, Ave. "G," Brooklyn, N. Y.

GARLAND, Caude Mallory (Associate, 1906), Instr. in Mech. Eng'g. University of Illinois, Urbana, Ill.

GORTON, John C. (1897; 1899), The National Cash Register Co., and *for mail*, 16 Lexington Ave., Dayton, O.

GRAY, John Wilson (Junior, 1895), Representative, Newport News Shipbuilding & Dry Dock Co., Newport News, Va., and *for mail*, The Normandie, 36th and Chestnut Sts., Philadelphia, Pa.

HACKNEY, Wm. W., Jr. (Junior, 1906), Production Dept., Western Gas Construction Co., Fort Wayne, Ind.

HALDEMAN, Paul Collins (Junior, 1906), Asst. Master Mech., Lukens Iron & Steel Co., and *for mail*, Speakman Hotel, Coatesville, Pa.

HALSEY, F. A. (1882), Editor, "American Machinist," Hallenbeck Bldg., 505 Pearl St., and *for mail*, 356 West 120th St., New York, N. Y.

HARDING, Adalbert (Junior, 1898), Westinghouse Machine Co., 10 Bridge St., and 69 West 49th St., New York, N. Y.

HAVEN, Henry, M. (1904), Refrigerating Engr., F. W. Dean, Room 1112, Exchange Bldg., 53 State St., Boston, and *for mail*, 3 Boston St., Somerville, Mass.

HILL, William (1883; 1889), President, The Collins Co., Collinsville, Conn.

HUTCHINSON, Arthur H. (1899), Larsen-Baker Ice Machine Company, 20th and Nicholas Sts., Omaha, Nebr.

JACKSON, Dugald C. (1890), Massachusetts Institute of Technology, Boston, Mass.

KEVORKIAN, Zareh H. (Junior, 1905), Brown-Cochran Company, and *for mail* 633 Twelfth Ave., Lorain, Ohio.

KIRK, Robert H. (1895;1903), care of Parker & Lee, 20 Broad St., New York, N. Y.

KLEIN, Joseph F. (1881), Life Member; Prof. Mech. Eng'g, Lehigh University, S. Bethlehem, and 357 Market St., Bethlehem, Pa.

LANE, Francis W. (Associate, 1900), Resident Editor, "The Railway Age," 150 Nassau St., New York, N. Y.

LAWRENCE, J. P. Stuart (1885), Present address unknown.

LEVIN, Arvid Michael (1894), Minneapolis Steel & Machinery Company, Minneapolis, Minn.

LILLE, Grant W. (Junior, 1901), Supervisor of Car Dept., "Frisco Systems," St. Louis, Mo.

McDEVITT, Frank J. (Junior, 1906), Asst. to Master Mech., Youngstown Iron Sheet & Tube Co., and *for mail*, 280 Custer Ave., Youngstown, Ohio.

MacGREGOR, Walter (1906), American Steel Foundries, First National Bank Bldg., and *for mail*, 3609 Ellis Ave., Chicago, Ill.

MADDOCK, George F. (1903), Charleston, W. Va.

MAIN, Charles T. (1885), Mill Engr. and Arch., Room 911, 45 Milk St., Boston, and 14 Herrick St., Winchester, Mass.

MASURY, Alfred Fellows (Junior, 1904), Asst. Engr., Hewitt Motor Co., 6 East 31st St., and *for mail*, 44 West 25th St., New York, N. Y.

MILLER, Fred. J. (1890), 34 Beech St., East Orange, N. J.

MORGAN, Ralph Landers (1900; 1902), Works Engr., E. R. Thomas Motor Co., Buffalo, N. Y.

MORRIN, Thos. (1897), Cons. Engr., 15 Second St., San Francisco, Cal.

MUIR, John J. (1896), Mech. Engr., 345 West Wayne St., Fort Wayne, Ind.

MUNBY, Ernest J. (1906), Engr. and Dir. Auriferous Pyrites By-Products Co., Asst. Supt. Mech. Dept., S. Pearson & Son (Inc.), Contractors for Penn., N. Y. & L. I. R. R. East River Tunnels, 146 East 36th St., New York, N. Y., and Baddon Park, Essex, England, and *for mail*, 301 Hudson St., Hoboken, N. J.

NORTON, Harold P. (1906), Commander U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

NOYES, Henry (1899), Life Member; Noyes Bros., 153–7 William St., Melbourne, Australia.

PARKER, John Henry (Associate, 1901), Machine Designer and Expert, Rippel Bldg., 7 Clay St., and *for mail*, 2215 Ruskin Ave., Baltimore, Md.

PAYSON, T. Elliott (Associate, 1906), M. E., care of Mrs. Barnett, 237 West 4th St., New York, N. Y.

PENTZ, Albert D. (1891), 174 South Common St., Lynn, Mass.

PETTIS, Clifton Dancy (1905), Hewitt Mfg. Co., 303 Railway Exchange, Chicago, Ill.

QUIRK, Wm. M. (1903), care of Bevan & Edwards Property (Ltd.), Latrobe St., Melbourne, Australia.

RAMSDEN, John Thomas (1906), Asst. Mgr., Tabor Mfg. Co., and *for mail*, 2646 North 17th Street, Philadelphia, Pa.

REED, Edgar Howard (Junior, 1905), Supt., Reed & Price Mfg. Co., Duncan Ave., and *for mail*, 21 Stoneland Road, Worcester, Mass.

RICKER, Wm. Wood (1906), Western Union Bldg., Chicago, Ill.

SCHREUDER, Andrew M. (Junior, 1898), Tabor Mfg. Co., 18th and Hamilton Sts., Philadelphia, and *for mail*, 6201 Germantown Ave., Germantown, Philadelphia, Pa.

SHEPPARD, John Leefe, Jr., (Associate, 1906), Mech. Engr. and Draftsman, 222 Chestnut St., Harrisburg, Pa.

SLATER, Alpheus B. (1891), General Manager, Rio Gas Company, Rio de Janeiro, Brazil, South America.

SMART, Richard Addison (1894; 1900; 1906), Asst. Supt., Westinghouse Elec. & Mfg. Co., East Pittsburg, and 423 Ross Ave., Wilkinsburg, Pa.

SMITH, Edward Jos. (1904), Traylor Engineering Company, Allentown, Pa.

SMITH, Roy Brooke (Junior, 1905), 60 Jefferson Ave., Logansport, Ind.

SMITH, Roy Harman (Junior, 1906), Supt., National Screw & Tack Co., Cleveland, Ohio.

SNYDER, Robt. M. (Junior, 1890), 10 West 104th Street, New York, N. Y.

SPOTTON, Arthur Knowlson (Junior, 1906), Ch. Engr., The Goldie & McColloch Co., Ltd., Galt, Ontario, Canada.

STEARNS, Charles K. (1899), Mech. and Elec. Engr., Broad Exchange Bldg., 88 Broad St., Boston, Mass.

STEELE, Walter D. (1892; 1901), Benjamin Elec. Mfg. Co., and *for mail*, 42 West Jackson Boulevard, Chicago, Ill.

STILLMAN, F. H. (1887), Pres., The Watson-Stillman Co., and the Bridgeport Motor Co., 25 Dey St., New York, and *for mail*, 105 Rodney St., Brooklyn, N. Y.

STRATTON, James Hughes (1906), Engr. of Constr., Wellman, Seaver, Morgan Co., Cleveland, Ohio.

SUNSTROM, Karl J. (1884), Cons. Engr., Odengatan 92, Stockholm, Sweden.

THOMAS, Edward G. (Junior, 1890), Mech. Engr., 88 Broad St., Boston, Mass.

TOLTZ, Max E. R. (1904), Rooms 314–315 Nat. German American Bank, St. Paul, Minn.

TOWNE, Thos. (Associate, 1895), Eastern Sales Agent, Union Drawn Steel Co., Washington and Canal Sts., New York, N. Y., and Beach St. and Prospect Ave., Hackensack, N. J.

TREGELLES, Henry (1888), care of Wessel, Duval & Co., Valparaiso, Chile, South America.

VAN VALKENBURGH, Ralph D. (1901; Associate, 1905), 1062 Millard Ave., Chicago, Ill.

VOORHEES, Gardner Tufts (1900); Refrig. Engr., 53 State St., Boston, Mass.

WETTENGEL, C. Albert (Junior, 1903), 202 East St., Iola, Kansas.

WHEELER, Wm. Trimble (1905), Genl. Mgr., Trinity Engg. Co., 107 Liberty St., New York, N. Y.

WILCOX, John F. (1887), 115 Paulison Ave., Passaic, N. J.

WILDIN, Geo. W. (1901), care of Supt. Motive Power's Office, Lehigh Valley R. R. Co., South Bethlehem, Pa.

WISEWELL, Francis Henry, Jr., (Junior, 1905), 201 Greene Ave., Brooklyn, N. Y.

WOODWARD, Robt. S., Jr. (Junior, 1904), Mech. Engr., 2 Wall St., New York, N. Y

ACCESSIONS TO THE LIBRARY

DONATIONS[1]

REPORT OF THE ELECTRIC RAILWAY TEST COMMISSION to the President of the Louisiana Purchase Exposition. *McGraw Publishing Company, New York, 1906.* $8.00 cloth, $6.00 net, postpaid.

Contents by chapter headings: Service Tests of Electric Cars; Service Tests of a Single Truck City Car; Service Tests of a Double Truck City Car; Service Tests of an Interurban Car; Acceleration Tests on a Single Truck City Car; Acceleration Tests of an Interurban Car; Compressor Station Tests of a Storage Air System of Braking; Braking Tests on a Double Truck City Car Equipped with Air Brakes; Braking Tests on an Interurban Car Equipped with Air Brakes; Braking Tests on a Single Truck City Car Equipped with Magnetic Brakes; Tests of a Storage Battery Industrial Locomotive; Alternating Current Losses in Steel Rails and in Other Steel and Iron Sections; Alternating Current Losses in Track; Train Resistance Tests of Interurban Cars; The Test Car "Louisiana;" Air Resistance Tests; General Data Relating to Electric Cars.

EXCHANGES AND PURCHASES

PRACTICAL MARINE ENGINEERING. By William F. Durand. *New York, 1901.*

ANNUAL REPORT OF THE DEPARTMENT OF WATER SUPPLY, GAS AND ELECTRICITY. *New York, 1906.*

ANNUAL REPORT OF THE WATER BOARD OF THE CITY OF CAMBRIDGE, MASS. *1906.*

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. *Proceedings. December, 1906.*

THE ENGINEERS SOCIETY OF WESTERN PENNSYLVANIA. *Proceedings. January, 1907.*

REPORT OF THE LIGHT HOUSE BOARD to the Secretary of Commerce and Labor, 1906.

REPORT OF THE COMPTROLLER OF THE CITY OF NEW YORK for the Fiscal Year 1904.

[1]Books in this list have been donated by the publishers.

CANDIDATES FOR MEMBERSHIP

Record of Qualifications, Engineering Experience and References

This list should be treated as confidential and is subject to inspection by members of the Society only. The names are those of candidates whose applications have been approved by the Membership Committee and the Council. The names appear in the same order as on the ballot sent to the voting membership, closing March 30, 1907.

TO BE VOTED FOR AS MEMBERS

E. A. BARNES

E. A. BARNES, Semet Solvay Co., Syracuse, N. Y. Born Syracuse, N. Y., 1876. M. E., Cornell University, 1899. Drawing-room, Solvay Process Company, Syracuse, N. Y., 1890-1894, and summer months, 1894-1898; Civil Engineering Department, 1899-1901; Assistant to Engineer of Tests, 1900-1903; Inspection Department 1903-1904; Engineer of Tests, Semet Solvay Company, 1904 to date; in general control of the power plants of the company having supervision and entire responsibility for the selection and operation of steam and gas machinery at the various coke oven plants, and special investigations covering methods of operation, adaptability of new machinery, etc., for past two years.

References: Geo. M. Brill, W. H. Blauvelt, W. B. Cogswell, J. H. Barr, R. C. Carpenter.

FRANK BURR BIGELOW

FRANK BURR BIGELOW, 1541 Marquette Bldg., Chicago, Ill. Born Washington, D. C., 1871. Shop experience, Westinghouse, Church, Kerr & Co. (Cragin, Ill.), erecting, testing and sales. Roney Mechanical Stoker, 1888-1893. American Stoker Co., testing and sales, two years. Four years Murphy Iron Works (Detroit, Mich.), construction, erection, testing and sales. Manager Murphy Iron Works.

Rerefences: Jno. M. Sweeney, H. B. Prather, A. Sorge, Jr., F. Blossom, Jas. W. Lyons.

F. E. BOCORSELSKI

F. E. BOCORSELSKI, Baush Mch. Co., Springfield, Mass. Born Hartford, Conn., 1876. Two years Trinity College. Apprentice, Pratt & Whitney Co., 1891. Drawing-room, Pratt & Whitney and Chief Draftsman at the Baush Mch. Tool Co., 4 years. American Patents, New York Subway, designed sheathing machine. Present position, Baush Machine Tool Co., Springfield, Mass.

References: Jno. Riddell, Dudley S. Seymour, Jas. McNaughton, Wm. L. Reid, Thos. J. Rider.

WILLIAM LESTER CANNIFF

William Lester Canniff, 136 East 48th Street. Born Berea, Ohio. Chief Engineer, J. S. Casement & Co. (Cleveland, O.), 1889-1891. Chief Engineer of Ship Owners' Dry Dock Co. (Cleveland, O.), 1891-1894. Engineer of Superior Street Viaduct (Cleveland, O.), 1894-1896. Master Mechanic, W. J. Gawne Co. (Cleveland, O.), 1896-1900. Master Mechanic, 1900-1903; Superintendent, 1903-1905, W. J. Gawne Co. (Cincinnati, O.). Present position, Master Mechanic, The Degnon Constructing Co.

References: H. O. Pond, Justin Greiss, Jr., D. L. Hough, J. D. Logan, F. J. Logan.

ALFRED BANGS CARHART

Alfred Bangs Carhart, 10 Roland St., Charlestown, Mass. Born Charles City, Iowa, 1872. Brooklyn Polytechnic, two years. E. E., Princeton, 1893. Apprentice at Witter & Kenton, (New York), in electrical litigation. 1893-1895. Drawing-room, laying out drawings for Patent Office applications, and study and interpretation of drawings of issued patents since 1893. Personal direction and supervision of draftsmen's work with Carolina Mineral Co., 1901. The Bates Machine Co., 1902-1905. Crosby Steam Gage Valve Co., experimental work, designing, testing and instrument manufacture. Consulting advisor on engineering and mechanical subjects for Alfred Sully (New York City), 1895-1902, in various enterprises. In the principal cities east of Chicago for the Automobile Oiling Co. (New York). General counsel for The Bates Machine Co. (New York), in aggressive patent litigation 1902-1906, and director. Treasurer and Director Carolina Mineral Co. (Marshall, N. C.), completion of the mill and operation of barytes mines, laying out and directing work of installing new machinery, 1901. General Mgr. of the International Box Hinging Machine Co., charge of construction machines and experimental work, in New York. Charge of the factory of The Bates Machine Co. (Brooklyn, N. Y.), 1902-1906. May, 1906, to date, Supt. in charge of the management and operation of the factory Crosby Steam Gage & Valve Co., (Boston, Mass.).

References: Jas. A. Tilden, Chas. Longenecker, Frank L. Dyer, F. N Willson, Marcus Powell, C. G. Ludlow.

NATHANIEL ALLEN CARLE

Nathaniel Allen Carle, 10 Bridge Street, New York. Born Portland, Oregon. Technical, Stanford University, A. B., 1898. Mining in Alaska, and operating electrical power house, 1898-1899. Assistant to president Canadian Rand Drill Co. (Sherbrooke, Quebec, Canada), 1899-1900. Westinghouse, Church, Kerr & Co., superintendent of construction on field work, erecting engineer Kingsbridge Power Station, N. Y., 1900-1903. Sales Manager New York office, Struthers Wells Co. (Warren, Pa.), 1903-1904. Westinghouse, Church, Kerr & Co., first assistant to Superintendent of Construction Long Island City Power House, Long Island Railway electrification. Superintendent of Construction and Engineer in charge of W. C. K. & Co.'s electrification Northern Colorado Power Co. (Colorado).

References: W. C. Kerr, W. W. Churchill, G. B. Caldwell, C. E. Lucke, A. W. Smith.

HARRY MAYNARD CHAMBERLAIN

Harry Maynard Chamberlain, 17 Wrentham St., Dorchester Center, Mass. Born Coventry, Vermont, 1876. Worcester Polytechnic Inst., B. S., 1899.

Drafting and engineering work Boston & Albany R. R. (Boston, Mass.), 1901-1904. N. Y. C. & H. R. R., N. Y. City, July-Nov., 1904. Schenectady Locomotive Works (Schenectady, N. Y.), 1899-1900. Locomotive construction work on erecting floor, Boston & Albany R. R., Sept., 1900-July, 1901, design work and special assignments N. Y. C. & H. R. R., 1904-1906.; indicated all steam-engine power at large repair shop, and planned distribution of motors for electric drive of shop equipment, comparative test of Stephenson vs. Walschaert valve motion on modern locomotives; in charge of N. Y. C. Lines dynamometer car and other test work. Present position, Mech. Engr. for Frank B. Gilbreth, Gen. Contractor and Manager Contractors' Machinery Rental & Transportation Co.

References: Wm. H. Larkin, Jr., F. M. Whyte, C. H. Quereau, C. M. Allen, J. E. Sague.

GEO. WM. CONNON

Geo. Wm. Connon, 11 Broadway, New York. Born at Aberdeen, Scotland, 1870. Three years Stanford University, Palo Alto, Cal. Apprentice at Aberdeen, Scotland, with David Milne & Sons, 1885-1889. Quebec Central Railway Co., shops Sherbrooke, Quebec, Can., 1889-1891. Brown Sharpe Mfg. Co., Providence, R. I., 1891-1892. Engineer for the McBryde Sugar Co., Eleele, Kauai, H. I., in charge of sugar factory, railway, and pumping plants, 1902-1905. Design and erected four electric pumping plants. Erecting, pattern making and draughting office. Draughtsman Honolulu Iron Works Co., Honolulu, H. I., 1896-1898. Head-draughtsman Canadian Rand Drill Sherbrooke, Que., Canada, 1898-1899. Honolulu Iron Works Co., 1899-1901. Present position, Engineer in charge of work New York Office of the Honolulu Iron Works Co., engaged in designing and remodeling cane sugar factories, distilleries, and general sugar plantation engineering.

References: C. Hedemann, Albert W. Smith, Dexter S. Kimball, Frederic A. C. Perrine, Andrew Sangster.

GEORGE WILLIAM COOKE

George William Cooke, 388 Hudston Street, Buffalo, N. Y. Born Surrey, England, 1869. Apprentice, Waterous Engine Co. (Brantford, Canada), 1887-1891. Drawing-room, Buffalo Forge Co. (Buffalo, N. Y.), Jan.-March, 1894, and Geo. N. Pierce Co., July, 1897-October, 1901. Shop experience, pattern and machine work, Geo. W. Shamp (Buffalo), Oct., 1891-Jan., 1894. Other practical experience, The Gould Coupler Co. (Depew, N. Y.), Snow Steam Pump Co. (Buffalo). Three years in charge of drafting department, Geo. N. Pierce Co., designing tools, jigs and fixtures. Superintendent, Geo. N. Pierce Co. for about four years and eight months. Present position, Superintendent with the Geo. N. Pierce Co., engaged in manufacture of automobiles.

References: J. L. Osgood, F. H. Ball, H. L. Duerner, Jr., R. K. LeBlond, F. H. Robinson, E. A. Beaman.

CHARLES HENRY DELANY

Charles Henry Delany, 336 Sixth Street, Barberton, Ohio. Born San Francisco, Cal., 1874. B. S., Technical University of California. M. M. E., Cornell University, 1903. Apprentice, San Francisco, Cal., Union Iron Works Draughting Room, 1897-1900. Drawing-room, Union Iron Works, 1900-1901. Abner Doble Co., San Francisco, March-Aug., 1901. Stirling Company, Barber-

ton, O., 1902-1903. Shop Experience, Mare Island, Cal., with U. S. Navy Yard, 1896-1897. Traveling Engineer and tests of water tube boilers at various plants throughout the country, Stirling Co., 1903-1905. In charge of the Order Department at the works, Barberton, O., June-Oct., 1905. Office Engineer at the works of Stirling Consolidated Boiler Co., special designing work, and testing special furnaces; preparing preliminary arrangements of boiler plants, estimating costs, and carrying on considerable engineering correspondence, 1905 to date.

References: Jas. P. Sneddon, Howard Stillman, Sandford A. Moss, Dexter S. Kimball, Wm. F. Durand.

JAMES HORACE DUNBAR

James Horace Dunbar, The Grasselli Chemical Co., Cleveland, O. Born Bay City, Mich., 1874. B. S. (C. E.), 1895, University of Michigan. Drawing-room work, 1895-1897, New Columbus Bridge Co. (Columbus, O.). Gillette-Herzog Mfg. Co. (Minneapolis, Minn.), July-Sept., 1897, and Pennsylvania Bridge Co. (Beaver Falls, Pa.), July-Oct., 1898, steel bridges and buildings. Koken Iron Works (St. Louis, Mo.), Transitman Detroit & Mackinac Railway 1897, location of extension north of Alpena, Mich. Mathiessen & Hegeler Zinc Co., (La Salle, Ill.), 1898-1903, designed and supervised erection of steel factory buildings, power plant, and special machinery and equipment for zinc smelting and for manufacture of sheet zinc and sulphuric acid, 1898-1903; last year of service charge of all the repair work. Mechanical Engineer, Grasselli Chemical Co. (Cleveland, O.), designed and installed special machinery for silicate of soda manufacture; sulphuric acid plant; power plant equipment and complete power plant; charge of operation of all power plants of company, 1903 to date.

References: Harold H. Hill, G. E. Merryweather, G. R. Murray, Wm. J. Reilly, W. Wilke.

ELMER GEORGE ELLIOTT

Elmer George Elliott, United Lead Co., Perth Amboy, N. J. Born Detroit, Mich., 1869. Four years Sedalia High School (Sedalia, Mo.); 1 year Sedalia University; 1 year Copper Union. Apprentice, Cordesman Machine Co. (Cincinnati, O.). Drawing-room, Guggenheimer Smelting Co., one year. General Electric Co. Repair Shop, Portland, Oregon, 1 year. One year installation work (Helena, Mont.). Charge of and installing electrical apparatus for The Boston & Montana Consolidated Copper and Silver Mining Co., 1 year (Great Falls, Mont.) One year installing machinery for Guggenheim Smelting Co. (Aguascalientes, New Mexico), including Corliss Engines, Hydraulic Apparatus for Cu. Converter Plant. In charge of electrolytic copper refinery and all generators, motors and electrical apparatus, including mechanical and electrical conductivity tests on copper wire., G. S. Co., 3 years. One and one-half years as Master Mechanic during construction of A. S. & R. Co. plant (Murray, Utah); 3 years installing large generators, steam turbines, etc., N. Y. Office General Electric Co. Present position, Master Mechanic United Lead Co., in charge of installation and operation power house equipment.

References: H. W. York. Calvin W. Rice, G. H. Reist, F. L. Antisell, F. W. O'Neil.

FRANCIS FARQUHAR

Francis Farquhar, York, Pa. Born York, Pa., 1868. Ph.D., Yale, 1888 Assisted during summer of 1886-1887 in survey of road-bed of part of the Duluth,

South Shore & Atlantic R. R. in N. Mich. Shop experience, A. B. Farquhar Co., Ltd., General Superintendent since May, 1899; acting as Secretary and Treasurer, 1906-1907. In charge construction new shops; responsible for all details of change of motive power from steam to electricity.

References: W. W. Dingee, Edwin H. Lockwood, C. K. Longnecker, Julian S. Scholl, Chas. D. Pierce.

EDWARD FARRAR

EDWARD FARRAR, Johannesburg, So. Africa. Born Elland, Yorkshire, England, March, 1854. Four years at Mechanics Institute, Huddersfield, Yorkshire. Trained in workshops of J. & J. Farrar, Millowners, in erection and maintenance of engines, boilers, and mill plant. Draughting-room. S. S. Stott & Co., Lancashire, 1876-1878. S. Hodge & Sons, London, 1878-1889. Outside Manager for Hodge & Sons, six years; Manager for the Hopcraft Furnace Co., London, one year. General engineering with Alfred Short, Durban, Natal; Mechanical Engineer to Denny Dalton Gold Mines, Transvaal; Chief Draughtsman to Consolidated Investment Co.. Johannesburg; Mechanical Eng. to Klerksdorp Proprietary Mines, Transvaal; Mechanical Engineer to Gen. Mining & Finance Cor., Johannesburg; Present position, consulting M. E. to General Mining & Finance Corporation, Johannesburg.

References: J. N. Bulkley, H. C. Behr, J. F. Cook, J. A. Vaughan, W. H. Wood, T. Reunert.

WANTON MARTIN GLADDING

WANTON MARTIN GLADDING, Morse Twist Drill & Machine Co., New Bedford Mass. Born at Newport, R. I., 1873. Rhode Island Tech., 2 years. Apprentice, Providence, R. I., Brown & Sharpe Mfg. Co., 1890. Shop experience, 4 years Brown & Sharpe Mfg. Co., U. S. Naval Torpedo Station eight years. Morse Drill & Mch. Co., four years. Foreman of Milling Machine Erecting Dept., Brown & Sharpe Mfg. Co. In charge of Auto Screw Machine Dept., U. S. Naval Torpedo Station. Foreman Tap, Die and Cutter, Dept. Morse Twist Drill & Machine Co. Present position, Mechanical Superintendent.

References: H. E. Cushman, F. M. Reed, Geo. R. Stetson, J. Osgood, W. A. Viall, H. D. Sharpe.

EDWARD PRESTON HAINES.

EDWARD PRESTON HAINES, Columbus, Ohio. Born Rancocas, N. J., 1873. M. E., Cornell University, 1896. Drawing-room, 1896-1897. Brown & Sharpe Mfg. Co., Providence, R. I., machine tools, detailing, laying out and checking milling machines, gear cutters, etc., 1897-1898. Maris Brothers, Philadelphia, April-Nov., 1898. Penn Iron Works Co., Phila., 1898, detail draftsman on Corliss and four valve engines; on the road indicating new engines, valve gear and governor expert; Westinghouse Machine Co., East Pittsburg, 1904-1905. Present position, Chief Engineer, Columbus Machine Co.

References: R. C. Carpenter, F. Schumann, Arthur West, M. R. Muckle, Jr., E. T. Adams, H. S. Riddell, Jno. S. Muckle.

JULIUS LAWRENCE HECHT

JULIUS LAWRENCE HECHT, 1213 Washington St., Chicago, Ill. Born Chicago, Ill., 1875. S. B., Mass. Institute Technology, 1904. Drawing-room, Chicago Edison Co., 1900-1901. Shop experience, Chicago Edison Co., 1895-1897. Inspec-

tor on power plant construction, installation of equipment, etc., 1897-1900. Assistant Engineer, S. S. Dorothea, government ship, June, 1904. Four weeks acted as chief engineer. Mechanical Engineer with U. S. Government Construction of office building for the U. S. House of Representatives and for U. S. Senate, charge of designing, drawing up specifications and charge of the installing of the complete mechanical equipment, 1904. North Shore Electric Company charge of the building of three central steam turbine plants and four sub-stations, rebuilding and managing eight old stations of the Company, 1905 to date.

References: C. G. Y. King, Geo. F. Gebhardt, Fredk. Sargent, W. S. Monroe, H. M. Montgomery.

FRED SUMNER HINDS

Fred Sumner Hinds, 19 Milk Street, Boston, Mass. Born Providence, R. I., 1850. Two years Providence Polytechnic Evening Schools. Architecture with Chas. Wilcox and Stone, Carpenter & Wilson, (Providence, R. I.), 1877-1882. Designing and construction drawings for all kinds of buildings, head draftsman of building construction dept., Lockwood, Greene & Co., 1883-1890, Providence, R. I., chief draftsman for both architectural and mechanical engineering departments, 1890-1900. Since June 1, 1900 in consultory work, Boston, clients have been; Rosemary Mfg. Co. (N. C.), L. S. Starrett Co., (Mass.), Fibreloid Co., (Indian Orchard, Mass.), J. R. Montgomery Co. (Conn.), Jno. Thomson Press Co. (Long Island City), etc.

References: J. F. Freeman, Chas. Y. Main, R. W. Eaton, C. B. Burleigh, L. H. Kunhardt.

ORMAN BROWN HUMPHREY

Orman Brown Humphrey, 63 Grove Street, Bangor, Me. Born Bangor, Me., 1867. Bowdoin College, 1886-1889, electing scientific and engineering courses. 1902-1906 mechanical engineering course International Correspondence Schools. Medical Schools of Columbia (New York), 1889-1890, Harvard, 1890-1892, M. D., Dartmouth, 1893, post-graduate course, medicine and chemistry Johns Hopkins, 1894. Engineering experience, Pioneer Woolen Mills (Pittsfield, Me.), 1901, Belknap Motor Co., (Portland, Me.), 1901-1902; Southern N. H. Electric Railway System in office of attorney for construction during last six months of construction of the roads, 1902. General engineering business as consulting and designing engineer at Bangor, Me., 1902 to date.

References: C. B. Clark, H. S. Ferguson, Wm. L. Church, E. N. Sanderson J. D. E. Duncan, H. L. Coburn.

HERMAN GUSTAF JAKOBSSON

Herman Gustaf Jakobsson, 148 S. Linden St., Bethlehem, Pa. Born Stockholm, Sweden, 1860. M. E., Technical College, Sweden, 1880. Apprentice, Norrkoping-Quist & Gjers, Arbogo, Sweden, rolling mills and turbines, 1881-1885. Drawing-room, Maxim, Nordenfelt and Vickers Sons & Maxim (London), thirteen years, Ordnance Inspector 18 months, England, with Vickers Sons & Maxim. Gerh Archns Machine Works, Stockholm, Sweden, as Shop Manager, 1899; charge of exhibit at Paris Ex., 1900, sales agent. Consulting Engineer, Stockholm, Sweden, 1901, Bethlehem Steel Co., (Bethlehem, Pa,), in charge of Ordnance Drawing Office, 1901, to date.

References: C. Von Philp, J. Frank Johnston, A. H. Helander, C. L. Grohmann, Maunse' White.

J. H. JOWETT

J. H. Jowett, 11 Broadway, New York, N. Y. Born Cleveland, Ohio, 1872 Three years High School, 3 years West Side Manual Training School, Cleveland. Apprentice, Marine Boiler Making, the Cleveland Ship Building Co. (Cleveland, Ohio), 1891-1892. Detail draftsman, Variety Iron Works of Cleveland, 1893-1894, detailing Thaw Steam Shovel. Draftsman with Steel Motor Co. (Johnstown, Pa.), 1894-1896. Anderson Dryer Co. (Cleveland, Ohio), 1896-1897. Draftsman, Ingersoll Sergeant Drill Co. (Easton, Pa.), 1897-1900, engaged in general Compressed Air Engineering and selling, 1900-1901. Sales Manager with direct charge and responsibility for engineering sales and superintending of construction of compressed air power plants, 1901-1906. Designed and superintended construction and completion of compressed air power plant for S. Pearsons & Son, Inc., of New York, in connection with P. R. R. Tunnels under East River. Present position, Manager N. Y. Branch of the Ingersoll-Rand Co.

References: H. L. Terwilliger, Frank Richards, William Prellwitz, Ward Raymond, Chas. W. Melcher, J. Stewart Thomson.

WILLIAM FREDERIC KIESEL, JR.

William Frederick Kiesel, Jr., 2320 Broad Ave., Altoona, Pa., born Scranton, Pa., 1866. M. E., Lehigh University, 1887. Apprentice, machinist trade, Lackawanna Iron & Steel Co., 1880-1882 and summer vacations 1882-1886. Shop Lackawanna Iron & Steel Co., Scranton, Pa. Draftsman, Pa. R. R. Co. charge of complete designs of Locomotives and Cars. Holding positions of Chief Draftsman, Assistant Engineer, 1888 to date. Present position, Assistant Mechanical Engineer.

References: A. S. Vogt, J. F. Klein, Thomas M. Eynon, Archibald Johnston, G. M. Basford, Chas. A Lindstrom.

EARNEST JAMES LEES

Ernest James Lees, Grant-Lees Machinery Co., Cleveland, O. Born Brampton, England. Six years at St. John's College, Surrey, England. Apprentice, Manchester, Ia. & Sioux City, Ia., Thomas Given and Mr. Chessman, 1890, on building construction and erecting gas engines. Draftsman Sioux City Engine Works and C. M. Giddings, Nov., 1892-1895, Chief Draftsman Ingersoll Milling Mch. Co, 1895-1901. Chief draftsmans Grant Tool Co., 1901-1902. Mechanical Engineer, C. M Conradson 1902-1904. Mechanical Engineer Browning Engineering Co., 1905-1906, designed and manufactured the first fifty Clark Automatic Telephones; designer and inventor of the line of large Ingersoll milling machines. Present position, Vice Pres't of the Grant-Lees Machine Co., and superintendent.

References: W. R. Warner, W. Ingersoll, H. M. Lucas, J. W. See, F. A. Halsey, Marcellus Reid.

FREDERICK H. LELAND.

Frederic H. Leland, 142 N. Fulton Ave., Mount Vernon, N. Y. Born Worcester, Mass. Worcester Polytechnic, S. B., E. E., M. E., 1895-1897. Apprentice, Washburn Shops (Worcester), and contractors in Boston, Expert Department General Electric Company, 1891-1896. Drawing-room, Emerson Electric Mfg. Co. (St. Louis), about one year. Shop experience, Worcester, Boston, St. Louis, New York, Schenectady, with concerns named in positions of foreman,

contractor, assistant to superintendent, purchasing agent, professional engineering work, designing and superintending construction and installation of various electrical and mechanical apparatus for experimental and commercial use, portions of three to six years. Present position, Production Engineer making physical and cost of production examinations for investors; devising and making effective methods for cost reduction, mechanical and otherwise.

References: H. F. J. Porter, Chas. H. Morgan, Milton P. Higgins, Geo. I. Alden, Wm. H. Morse.

WILLIAM WILSON LIGHTHIPE

William Wilson Lighthipe, Engineer, 17 Battery Place, New York. Born Vincetown, N. J., 1875. E. E., from Columbia University, 1898. Outside superintendent Metropolitan Electric Construction Co., 1898. Sprague Elevator Co., 1899; General Superintendent, 1900. Assistant superintendent, Otis Elevator Co., 1901-1902. Superintendent of Construction and Engineer, Marine Engine & Machine Co., 1903-1905. Engineer, Plunger Department Otis Elevator Co., 1906, to date.

References: B. N. Jones, F. R. Hutton, F. A. Scheffler, C. R. Pratt, G. C. Sims, Geo. B. Caldwell.

A. C. LINZEE

A. C. Linzee, Akron Mfg. Co., Akron, Ohio. Born Du Quoin, Ill., Jan., 1876. B. S. (in Elec. Eng.), University of Illinois, 1898. Draftsman, Blakeslee Mfg. Co., 1897 (Du Quoin, Ill.). General Electric Co., Schenectady, N. Y., 1902-1903. Engineer and Electrician in U. S. Navy, 1898-1899. Shop superintendent, Akron Electrical Mfg. Co., from 1904-1905. Present position, consulting engineer, Akron, Ohio, and Chief Engineer of the Akron Electrical Mfg. Co., Sept., 1905 to date.

References: H. C. Hale, L. P. Breckenridge, M. A. Replogle, E. M. Adams, W. L. Fergus.

NATHANIEL LOMBARD

Nathaniel Lombard, Lombard-Replogle Engineering Co., Akron, O. Born Springfield, Me., 1862. Apprentice at father's lumber mills, 10 years (Springfield, Me.), Hezekiah Lombard's Machine Shop, experimenting on special machinery, 1881-1882. Drawing-room, Boston American Arms Co., Lombard Water-Wheel Governor Co. (Boston), Improved Governor Co., Holyoke Machine Co., including special machine for making shoe trimmings; Plating Machine for Insulating Elec. Wires; automatic weighing scales; hydraulic air brake, lasting machine for shoes; machine for weaving water hose; Lombard hydraulic water-wheel governor; Lombard hydraulic relief valve; improved water-wheel governor; improved balanced water-wheel gates; joint designer of new Lombard-Replogle water-wheel governor, and designer of automatic gear planer, also installations of high grade machinery. Present position, superintendent and chief engineer, The Lombard-Replogle Engineering Co.

References: S. H. Pitkin, W. C. Johnston, Geo. J. Henry, Jr., Edw. M. Adams, Mark A. Replogle.

OTTO LUHR

Otto Luhr, 967 West Division Street, Chicago., Ill. Born Magdeburg, Germany, 1860. Technical education four years Magdeburg and Berlin. Appren-

tice Gruson Works (Magdeburg), 1880-1884; draftsman 1884-1886, Keystone Bridgeworks (Pittsburg) designer and superintendent of erection, consulting engineer, Hawley Down-Draft Furnace Co. (Chicago), 1886-1890. In charge of mechanical departments of all the plants belonging to the Chicago Brewing & Malting Co., Ltd., 1890-1900. Professor of Mechanical Engineering, Wahl-Hennis Institute, 1900 to date.

References: C. W. Naylor, E. B. Ellicott, J. Z. Murphy, Fred W. Wolf, C. G. Ludlow.

STEPHEN GRINNELL LUTHER

Stephen Grinnell Luther, 469 Prospect Ave., Buffalo, N. Y. Born Tiverton, Rhode Island, September, 1876. B. S., Worcester Polytechnic Institute, 1899. Drawing-room, Corliss Steam Engine Wks., International Power Co., and drafting and estimates on Greene-Wheelock and Corliss engines, 1899-1901. Two years fireman and oiler on steamers plying the Atlantic coast. One year as stationary engineer, Am. Fisheries Co. (Linekin, Me.), Stationary Engineer summer 1898. Draftsman W. A. Harris St. Eng. Co. (Providence, R. I.), 1901-1902 on Corliss Engine Work., designer and squad foreman Horizontal Corliss Dept., Westinghouse Machine Co. (E. Pittsburg), 1903-1903. Chief draftsman Gas Machinery Department Power & Mining Machinery Co. (Cudahy, Wis.), 1903-1905. Snow Steam Pump Wks. (Buffalo), charge of the development of a line of high speed double acting engines, 1905 to date. Present position, Asst. Chief Draftsman Gas Eng. Dept.

References: E. C. Lufkin, Sidney A. Reeve, Clarence N. Scott, E. S. McClelland, Wm. H. Morse.

HELON BROOKS MACFARLAND

Helon Brooks Macfarland, Asso. Prof. Applied, Armour Institute of Technology, Chicago, Ill. Born Trenton, Me., 1869. B. S., Worcester Polytechnic Institute, 1894; M. E., Cornell University, 1903. Teacher of Manual Training in Conn. 1894–1900. Installed Manual Training Dept. in State Normal College, Florence, Ala., 1900-1902. Constructing Engr. Lorain Steel Co., Lorain, O., summer 1903. Appointed Asso. Prof. of Applied Mechanics, Armour Institute of Technology, 1903, Consulting Engr. Acme Gas Co., Chicago, Ill., 1905-1906, design and installation of gas producer plants. Author "Standard Reduction Factors for Gases," Editor "Gas Power," 1906. Present position, Asso. Prof. Applied Mechanics, Armour Institute of Technology, special work, Gas Producer Installations.

References: Geo. L. Alden, Arthur L. Rice, Geo. F. Gebhardt, Chas. M. Allen, Chas. H. Sargent.

ARTHUR A. MERRITT

Arthur A. Merritt, 658 Broadway, New York, N. Y. Born Milford, Mass., 1860. Apprentice, L. L. Pollard, Worcester, Mass., 1877-1885. Evening drawing school in Worcester, Mass., between 1877 and 1885. Draftsman for Jones Special Machine Co. (Boston, Mass.), 1890-1892. Draftsman designer Special Stitch Machine Co., 1896-1898 (Worcester, Mass.). Draftsman Union Special Machine Co. (New York City), 1900-1906. Shop experience, 1877-1885 (excepting 1 year), general machine work, L. L. Pollard (Worcester, Mass.). One year Witherby, Rugg & Richardson (Worcester, Mass.). Part of 1886 with Barrett

Bros. (Boston, Mass.). Since 1886 high speed sewing machinery for factory use, for the firms of Pentucket Variable Stitch Machine Co. (Haverhill, Mass.). The Jones Special Machine Co., (Boston, Mass.) and Union Special Sewing Machine Co. (Chicago, Ill.). Responsible charge of machine design with the Special Stitch Machine Co. (Utica, N. Y.), obtaining four U. S. patents, 1898-1899. Draftsman and superintendent of experimental department Union Special Machine Co.(N. Y. City), 1900-1906. Present position, mechanical engineer Wilcox & Gibbs Sewing Machine Co., engaged in designing.

References: F. H. Colvin, H. D. Sharpe, W. A. Viall, E. H. Neff, H. F. Frevert.

SAMUEL L. MOORE

Samuel L. Moore, Elizabeth, N. J. Born Elizabeth, N. J., 1852. Apprentice, S. L. Moore & Son, as machinist, 1869-1873. Marine engineer's license, 1873. Followed the sea until 1876 and 1879. Foreman Machine Shop of S. L. Moore & Sons Co., 1879-1887. The Moore Brothers Company, President and General Manager, 1887 to date. Present position, Vice-President and General Manager of the Moore Brothers Company.

References: Harris Tabor, L. B. Miller, Douglas G. Moore, John D. Bird, Walter F. Prince, Jr.

HENRY NEWTON PHARR

Henry Newton Pharr, Olivier, La. Born New Iberia, La., 1872. B.A. Centenary College, 1892, B.E., Vanderbilt University, 1896. Asst. Supt. Glenwild Sugar Factory in grinding season, 1896-1899 in charge of Osgood Co., Dipper Dredge in canal digging and levee building through cypress swamps of Louisiana. Designed and constructed large drainage plant. Supt. Orange Grove Sugar Factory in time 1899-1906 plant remodelled and capacity increased from 250 to 750 tons daily. Present position, Supt. Orange Grove Sugar factory and manager narrow gague R. R. and Plantation interests.

References: E, A. Sammons, W. T. Magruder, R. T. Burwell, H. F. Rugan, A. M. Lockett.

JAMES C. POTTER

James C. Potter, Pres. Potter & Johnston Machine Co., Pawtucket, R. I. Born Glasgow, Scotland, 1855. Machinist's Institute, Glasgow. Apprentice, Glasgow, H. J. H. King & Co., 1869-1874, and Anchor Line Steam Ships Co. Drawing-room, designing with King & Co. and with Anchor Line Steam Ships Co. for 25 years. Manager and President of Potter & Atherton Machine Co.; Howard & Bulloch, and with Potter & Johnston altogether a period of 26 years. Thirty-six years practical experience as machinist, draughtsman, experimenter, inventor and manager. Present position, President and General Manager of the Potter & Johnston Machine Co., engaged in manufacturing automatic machine tools.

References: Frank Mossberg, Henry D. Sharpe, William A. Viall, Richard H. Rice, E. P. Bullard.

CHARLES DELOS RICE

Charles Delos Rice, Supt., Underwood Typewriter Company. Born Auburn, N. Y., 1859. General Machine work, machine construction and tool making Tool department foreman in a large plant including the supervision of machine and tool designing. Chief Engineer for Pope Mfg. Co., Columbia Factory, includ-

ing their associate factories for a period of more than ten years. Past six years General Supt. Underwood Typewriter Co. While associated with the Pope Mfg. Company and Underwood Typewriter Co. engineered the designs of not less than fifty manufacturing machines, distinctly different in type, including forging machinery, hydraulic plants, gear cutting, milling, drilling, shaping and swedging machines, punching and coining presses and in a consulting capacity with prominent manufacturing concerns. Present position, Supt. of Underwood Typewriter Co., engaged in typewriter manufacture.

References: Wm. A. Viall, Henry D. Sharpe, Flavel S. Luther, Lewis C. Grover, Fred C. Billings, Henry Souther.

EDW. V. SEDGWICK

Edw. V Sedgwick, 34 Rue du Louvre, Paris, France. Born at Stockham, Cal., 1860. Mass. Institute of Technology, special student Mech. Eng. class, 1884. Apprentice, Stockham, Cal., with Stockham Iron Works, machinist trade, 1877-1880. Draftsman, machinist and foreman Master Mechanic Central Ry., City of Mexico, Silao, San Luis, Potosi Junilco and Tampico, 1885-1889. Supt. M. P. & M. Duluth, South Shore and Atlantic Ry. and Marquette, Mich. 1889 Supt. M. P. & M. Interoceanic Ry. at Puebla, Mexico, 1897. European Manager Salena Signal Oil Co.

References: B. Haskell, G W. Wildin, W. E. Symons, James McNaughton, E. W. Grieves.

W. D. SHERMAN

Willis Durwood Sherman, 521 East 8th Street, Kensington, Brooklyn N. Y. Born August, 1859, Dixon, Ill. Apprentice, in the manufacture of agriculture machinery, 1871-1883 (Dixon, Ill.). Drawing-room Union Hydraulic Drain Tile Co. (Omaha, Neb.), 1883-1889 and Wilson and Baillie Mfg. Co., 1889 to present time. Usher and Russell, 1883-1886. Davis & Cowgill, 1886-1889 Wilson & Baillie Mfg. Co., Brooklyn, N. Y., 1889 to date. Designed and perfected machine for manufacture of cement, egg-shaped and round sewer pipe; perfected and put in plant with Baillie Mfg. Co. Designed and built carrier covering the yard of the Wilson & Baillie Mfg. Co., 1008 x 210′ doing all the work of a bridge crane. Designed, built, erected and operated system for the Albany filter plant, as Superintendent and mechanical engineer, built mixer and engines for system for the concrete sea walls for the greater part of the Wallabout Basin, and cob dock Brooklyn Navy Yard. At present designing and building automobile engines for automobiles and small yachts.

References: Calvin W. Rice, D. W. Mesick, Chas. W. Baker, Spencer Miller, Warren Hill.

GEO. W. K. TAYLOR

Geo. W. K. Taylor, 104-106 John Street, N. Y. City. Born New York City. B. S. Cooper Union, 1877. Eaton, Cole & Burnham Co., New York, and Bridgeport, Conn., 1874-1893, designing, manufacturing and superintending special valves, fittings, etc., for high pressure steam work for power stations. McMann & Taylor, making a specialty of designing, manufacturing and superintending work for power plants. Equipped steam power plants of Baltimore, Md., Traction System, and Columbus (Ohio) Edison Electric Light Co., in U. S. and abroad 1893 to date.

References: Geo. A. Suter, M. W. Sewall, Wm. B. Ruggles, Wm. H. McKiever, Edwin H. Ludeman.

AMBROSE GILMORE WARREN

Ambrose Gilmore Warren, Mechanical Engineer, 1613 Green St., Phila., Pa. Born Hubbardstown, Mass., 1873. Worcester Polytechnical Institute, S.B. Three years Deane Pump Co., Holyoke, Mass. General work and designing jigs and fixtures; six months Farrel Fdy. & Mach. Co. Conn., general work and shop engineering. Shop experience one year Deane Steam Pump Co. Present situation Mechanical Engineer, July, 1900, J. W. Paxson Co., Phila., Pa., charge of drawing-room and machine shop.

References: Chas. L. Newcomb, Chas. L. Griffin, W. P. Dallett, Albert A. Carey, H. O. Evans, David R. Bowen.

KENNETH L. WARREN

Kenneth L. Warren, Fraserville, Quebec, Canada. Born at Lowville, Lewis County, N. Y., 1865. Four years Lowville Academy. Apprentice, Lowville, New York, The Lowville Iron Works Co., general shop work, drafting, etc. and general supervision of shop 1889–1892. Frontenac Paper Co., Dexter, New York, nine years, afterwards Manager; Designed and built in 1901–1902, a six grinder Pulp Mill for the River du Loup Pulp Co. Ltd., Fraserville, Quebec, having full charge of construction, erection of Mill, and installation of equipment, which is present position, manager in full charge of all operation. Redesigned and rebuilt pulp machine originally patented by J. S. Hughes 1902–1903. Eight machines are now in successful operation in the Mill of the River du Loup Co. and Bagley & Sewall Co., Watertown, N. Y. Consulting Engineer for Corporation of Fraserville for past three years. In general Engineering practice and Manager.

References: Jos. H. Wallace, Geo. F. Hardy, Wm. G. Matheson, Clarence E. Kinne, M. S. Morehouse.

JAMES THOMAS WHITTLESEY

James Thomas Whittlesey, 39 Lloyd Place, Montclair, N. J. Born Brunswick, Me., 1866. B.A. Yale, 1889. Shop experience, Lynn, Mass., 1889–1890. N. W. Thomson Houston Co. (St. Paul, Minn)., 1890. N. W. Thomson Houston Co. (Portland, O.), 1890–1. Built Elec. Rwy., near Portland, 1890. C. H. Davis, Consulting Engineer, (New York) 1891–1892. Brooklyn City Ry., 1892, Supertendent Car Shops. Chief Engineer Brooklyn Heights R. R. 1896. Superintendent Stephenson Car Co., 1898. Chief Engineer United Elec. Co. (Newark, N. J.), 1900. Chief Engineer Elec. Dept., Public Service Corp. of N. J., 1903 to date. Present position, Chief Engineer Electrical Department Public Service Corporation of N. J., estimates, reports, design and construction of power stations and extensions of storehouses and conduits for the Company.

References: Hosea Webster, Dudley Farrand, R. H. Rice. G. J. Roberts, C. H. Davis, C. W. Rice, C. W. Baker.

REGINALD ASHMUN WRIGHT

Reginald Ashmun Wright, Mechanical Engineer, Sherbrooke, Quebec. Born at Akron, O. 1876. Case School of Applied Science, B.S., 1897. Drawing-room Akron. O. Webster, Camp & Lane Co., 1900–1903. Experience eight months each with Penn. Co., Titusville Iron Co., Struthers, Wells & Co., Pierce Grouch Eng. Co., in field and drafting room. Shorter times with Replogle Governor Wks. and Yale & Towne Mfg. Co., the last year with Webster, Camp & Lane Co.

in charge of drafting room, one year Wellman-Seaver-Morgan Co., foreman of mining machinery department of drafting room, Cleveland, O. and for the last year and a half Chief Engineer of the Jenckes Machine Co., Sherbrooke. Present position of Chief Engineer, Jenckes Machine Co., Ltd.

References: C. H. Benjamin. S. H. Pitkin, H. C. Hale, M. A. Replogle, M. J. Bigelow.

FOR PROMOTION TO MEMBERS' GRADE

FREDERICK OSSIAN BALL

Frederick Ossian Ball, 44 Washington Ave., Plainfield, N. J. Born Grand Island, Erie Co., N. Y., 1872. M. E. Stevens Institute, 1897, apprentice Ball Engine Co., 1890. Drawing-room Ball & Wood (Elizabeth), 1890–1896; American Engine Co. (Bound Brook, N. J.), steam engines and electrical machinery, 1896 to date. In charge of drawing-room American Engine Co. from beginning of connection with that corporation, during which time designed and brought out duplex compound steam engine on which were obtained several patents. Charge of electrical engineering for American Engine Co. Present position, Assistant General Manager American Engine Co. in charge of all designing. Elected Junior Member 1901.

References: D. S. Jacobus, J. E. Denton, C. H. Corbett, F. H. Ball, Wm. H. Corbett.

WALTER CARTER DICKERMAN

Walter Carter Dickerman, 25 Broad Street, New York City. Born So. Bethelehem, Pa., December, 1874. M. E. Lehigh University, 1896. Murray, Dougal & Co., Ltd. (Milton, Pa.), freight car design, 1897–1898; supervising freight car construction and preparing costs, 1898–1899; Assistant General Manager, 1899–1900; American Car and Foundry Co. (successors) supervising operation of plant. American Car and Foundry Co. (New York City) Sales Agent, 1900; General Sales Agent 1902; 3d Vice President 1905–1907. Present position, 3rd Vice President American Car and Foundry Co., engaged in selling and suggestive design of railroad equipment.

Elected Junior Member in 1899.

References: J. F. Klein, C. H. Zehnder, H. F. Glenn, G. S. Humphrey, Geo. I. King, Geo. W. West.

WALTER GRANT HOLMES

Walter Grant Holmes, 44 West Seventh Street, Erie, Pa. Born Milton, Mass., August, 1869. Apprentice Brainard Milling Mach. Co., 1884–1888. Draughting-room Boston Blower Co., 1889–1891. Shop, B. F. Sturtevant Co., Boston, 1888–1889. Superintendent Boston Blower Co., 1889–1899. Following positions: New York Blower Co., Superintendent, General Supt., purchased machinery, designed all apparatus and organized shop, 1899–1901. So. Bend Paper Co., designed line of self-opening paper machines 1901. Dodge Mfg. Co., special machine designing, plant work and improvements, 1902. Present position Supt, Taper Sleeve Pulley Works, Erie, full charge of factory designing.

Elected Associate Member, 1897.

References: E. C. DeWolfe, Geo. I. Rockwood, Geo. F. Waddell, Walter I. Brock, W. E. Roe, Melville W. Mix.

HENRY SMYTH ISHAM

Henry Smyth Isham, 951 Park Ave., New York City. Born New Britain, Conn., 1866. Apprentice Wm. A. Harris Engineering Works, 1882–1886. Drawing-room, 1887–1888, R. I. Loes Works. Draftsman and assistant Shop foreman for Bentoney & Knight underground trolley construction. Draftsman for the Clark-Howard Co., 1899. Draftsman in charge of office, Jeffrey Mfg. Co., Columbus, O., 1889–1892. Draftsman Johnson Steel Co., Johnstown, Pa., Street Ry., Dept., 1892–1893, inspector on some of the installation of track for Third Ave. Cable Road, N. Y. City, 1895. Draftsman Pond Mch. Tool Co. Draftsman Washington Alexandria & Mt. Vernon Ry., 1895. Draftsman Mossburg Mfg. Co., Attleboro, Mass., 1 year. Draftsman Met. Ry. Co., 1897–1899. Chief Draftsman San Paulo Ry. Lt. & Pr. Co., San Paulo, Brazil, 1899–1901. Draftsman for Pen Steel Co., 1901–1903, especial work. Present position, Chief Draftsman Ford, Bacon & Daviz.

Elected Junior Member.

References: W. B. Yereance, B. L. Baldwin, Geo. Arnold, F. S. Pearson, Wilbur M. Ruth, Percy A. Sangnetti.

JAMES FREDERICK LOCKWOOD

James Frederick Lockwood, 678 McDonough St., Brooklyn, N. Y. Born Cross River, N. Y., 1865. B.M.E. University of Maine, 1886.; M.E., 1889, Chief Draftsman, Otis Elevator Co., 1888–1899. Asst. Supt. Construction, 1899–1904. Present position, Manager Security Elevator Safety Co.

Elected Junior Member.

References: Griffith Jones, O. T. Smith, D. L. Holbrook, A. C. Smith, F. E. Town,

JOHN GILLETTE MATTHEWS

John Gillette Matthews, Three Rivers, Mich. Born Cleveland, Ohio, Sept., 1862. Special studies, Oberlin College, 1884–1887. Draughting-room, Pratt & Whitney, Hartford, 1888–1889. Shop, Elyria Screw and Tap Co. (now Western Auto. Machine Co.), Elyria, O., 1880–1881; Warner & Swasey, Cleveland, 1882–1883. Sheffield Car Co., Three Rivers, Mich., 1887–1888. Pratt & Whitney, Hartford, 1888–1889; Bement Miles & Co., Philadelphia, 1889; Sheffield Car Co., in charge of tool room and keeping shop machinery in repair, organized tool room and established present tool system. Other engineering work with Sheffield Car Co., charge of drawing-room 1894–1898; charge of motor car and steel velocipede design and special engineering work, 1899–1902. Lodge & Shipley M. T. Co., charge screw, machine tool work, 1903. Present position, Manager Three Rivers Tool Co.,

Elected Junior Member, 1897.

References: H. M. Leland, Wm, Lodge, Ambrose Swasey, W. N. Rumley, J. Wendell Cole.

SPENCER SMITH RUMSEY

Spencer Smith Rumsey, 610 Wolvin Bldg., Duluth, Minn. Born Berlin, Wisconsin, 1876. University of Wisconsin. B.S.C.E., from Univ. of Wis. Drawing-room, 1897 to 1900, E. P. Allis Co., Milwaukee, Wis. Power and Blow-

ing Engines, 1900–1906, Oliver Iron Mining Co., charge directly under Mr. J Wessinger, Chief Engineer, of designs and details of steam and hydraulic power plant, etc.

Elected a Junior Member, 1903.

References: H. J. Wessinger, T. M. Prescott, W. E. Dodds, T. W. Hugo, C. A. Johnson.

THOMAS FITCH SALTER

THOMAS FITCH SALTER, Philadelphia, Pa. Born Prattsville, N. Y., Mar., 1875. Apprentice Syracuse Specialty and Mfg. Co., 1893–1896. Draughting room, General Electric Co., Schenectady, C. W. Hunt Co. Shop experience, Carnes Cycle Co. and Frontenac Mfg. Co., tool maker and foreman tool and assembling department, 1895–1897; Foreman Thompson Pneumatic Spring Co. and shops on Atlantic Coast, 1897–1899. Present position, Engineer and Works Manager North Penn Iron Co., active shop management and responsible for design and construction of centrifugal pumps, cranes and structural work.

Elected Associate Member, 1905.

References: C. C. King, W. D. Stivers, Edgar H. Berry, Jas. W. W. Calwell, John Calder.

GODFREY MAYNELL S. TAIT

GODFREY MAYNELL S. TAIT, 39 Upper Mountain Ave., Montclair, N. J. Born London, England, 1876. Apprentice, J. Selwin Tait & Sons, mechanical work and office engineering, 1893–1986. Assistant Manager Smith-Vassar Telephone Co., New York. Shop, Smith-Vassar Telephone Co., New York, 1897–1898; Bell & Cuyahoia Telephone Co., 1898–1900; Schlicht Combustion Process Co., New York, 1900–1903; R. D. Wood & Co., Philadelphia, 1903–1905. Designed and superintended installation of power plants, A. F. Bornot & Bros., Phila.; Barber Chemical Co., Florida; Maryland Casualty Co., Baltimore; N. Y. Transportation Co., Newport, R. I.; Lozier Motor Co., Plattsburg, N. Y.; Royle & Akin, Ossining, N. Y. Installed producer plants covered by own patents, at National Meter Co., John Thompson Power Co. Present position, Manager Power Department Combustion Utilities Co., New York City.

Elected Associate Member, May, 1906.

References: Geo. H. Barrus, Byron E. Eldred, H. C. Abell, C. W. Scribner, Lewis H. Nash.

EDWARD G. THOMAS.

EDWARD G. THOMAS, 4 State Street, Boston, Mass. Born Waltham, Mass., 1865. Mass. Institute of Technology, 1887. One year with Thomas Edison's private laboratory (Orange), as draftsman and experimenter. Thomson Houston Co., San Franscico, electrical construction. Two years in Denver in consulting engineering, testing engines and boilers, machine design, etc. One year agent and engineer Edison General Elec. Co., Montana. One year Superintendent Butte General Elec. Co. since 1893 in general mechanical engineering in Boston.

Elected Junior Member, 1890.

References: Henry Souther, Edw. F. Miller, H. M. Montgomery, Chas. K. Stearns, Chas. R. Richards.

DANIEL WEBSTER TOWER

Daniel Webster Tower, Pres. Grand Rapids Brass Co., 156 Court St., Grand Rapids, Mich. Born Oakfield, Mich., 1858. Apprentice Phœnix Furniture Co. (Grand Rapids), Sept.–Aug. 1872. Drawing-room, Nelson Mather & Co., 1875 1882; Shop experience, Farmer & Tower, 1886–1888. Foreman Michigan Tool Works, 1882–1886. 1888–1906 Superintendent designing and building of factory buildings, planning and installation of power plant equipment, designing line of locks and other hardware. Present position, President Grand Rapids Brass Co.

Elected Junior Member June, 1900.

References: Geo. M. Bond, Chas. D. Reeve, Thos. Farmer, Jos. Garbett, A. M. Levin.

CLARENCE RAYMOND WEYMOUTH

Clarence Raymond Weymouth, 63 First St., San Francisco, Cal. Born 1876, Oakland, Cal. B. S., University of Cal., 1898. Apprentice various shops, 1890-1898, during the summer and winter vacations and other periods. Drawing-room, 1899-1902, Chas. C. Moore & Co., San Franscico, Cal.; Chief Draftsman, 1900-1902; inspector of work under construction and charge of installation 1900-1902. Present position, in charge of Engineering Department, Chas. C. Moore & Co.

Elected Junior, 1904.

References: Wm. D. Hoxie, E. H. Peabody, A. W. Smith, G. J. Henry, Jr., John Hopps.

ARTHUR JULIUS WOOD

Arthur Julius Wood, Asst. Professor Exp. Engineering, State College, Pa. Born Rosieville, N. J., 1874. Stevens Institute of Technology, M.E., 1896. Summer work in engineering at various places. Asso. Editor "Railroad Gazette" 1896-1900. Instructor Mechanical Engineering, Polytechnic Institute 1900-1902. Professor Mechanical & Elec. Engineering, Delaware College, 1902-1904. Asst. Prof. Exp. Eng'g., Pa. State College, State, 1904. Present position, Asst. Professor Exp. Engineering, Pa, State College, State College, Pa.

Elected Junior Member, 1898.

References: Louis E. Reber, Wm. T. Magruder, F. D. R. Furman, Chas. B. Peck, William Kent.

TO BE VOTED FOR AS ASSOCIATES

WILLIAM B. BRENDLINGER

William B. Brendlinger, 11 Broadway, New York, N. Y. Born Bridgewater, Pa., 1878. B. S. M. E., University of Pennsylvania, 1900. Ingersoll-Sergeant Drill Co., Easton, Pa., machine shop and erecting floor. Two summers Civil Engineering Corps as chainman and rodman. Two summers railroad contract work. Ingersoll-Sergeant Co., Salesman, 1901-1902; Assistant Manager and Engineer, Pittsburg Branch, 1902–1903. With P. F. Brendlinger as Assistant Superintendent, on Bradford Mills Contract of low grade freight line, Penna. R. R., and New Gallitzin Tunnel. Present position, Assistant New York Manager Ingersoll-Rand Co.

References: H. W. Spangler, A. M. Greene, Jr., F. W. Parsons, Wm. Prellwitz, H. V. Conrad, H. L. Terwilliger.

LEON WILSON CHASE

Leon Wilson Chase, Lincoln, Nebraska. Born at Jacksonville, Vermont, 1877. University of Nebraska, B. S. in M. E., 1904. At the University of Nebraska. Teaching work 4 years. In charge and one year as assistant. Two years in a large planing mill. Fairbanks, Morse & Co., their testing floor; one season assistant to the Windmill Superintendent. Designed, made working drawings, pattern work, casting, machining, erecting and testing of a gasoline engine. Present position, Assistant Professor Farm Mechanics, University of Nebraska.

References: C. R. Richards, C. E. Chowins, M. O. Price, W. F. M. Goss, F. G. Hobart.

BERTRAND JOSEPH CLERGUE

Bertrand Joseph Clergue, Sault Ste Marie, Ontario, Canada. Born Bangor, Me., 1873. Three years Mass, Institute Technology in mechanical engineering course; 1889 Bangor Street Railway Co.'s repair shop. Penobscot P. & P. Co. (Veazie Me.), Assistant, Engineer Lake Superior Power Co. 1895. Assistant Manager Lake Superior Power Co., 1896. Algoma Central Railway, Michigan Lake Superior Power Company and Tagona Water & Light Co., Feb., 1899-May, 1902, manager of above companies. At present engaged in consulting engineering work.

References: W. F. Prince, John Henney, J. H. Wallace, Wm. Clinton Brown, Wm. Schwanhausser, Geo. J. Foran.

THOMAS DAVIS

Thomas Davis, 1034 Neil Ave., Columbia, Ohio. Born Forrest City, Ark., 1876. 3 years at Cornell University; University of Nebraska, M. E., 1906. Stearns Roger Mfg. Co. (Denver), 1900, mill design and general drafting room and design work. Brawing-room, Mine and Smelter Supply Co. (Denver), Phillip Argall, Cons. Engr., Portland Cement Works (Portland, Colo.) and American Smelters Securites Co. During the last five years actively engaged in design of concentration mills, power plants and cement works, Colorado and in Mexico. For the past two years charge of designing and drawing rooms with above concerns. Adjunct Professor Machine Design University of Nebraska. Present position, Jeffrey Mfg. Co. charge of design.

References: C. R. Richards, C. E. Palmer, B. N. Wilson, W. N. Barnard, T. M. Gardner.

OSCAR VICTOR DE GAIGNE

Oscar Victor DeGaigne, 11 Murray Ave., Worcester, Mass. Born at Hungary, 1876. Four years Normal School, two at the Government Middle Schcols, five years Military Colleges. Three years Imperial and Royal Technical Military Academy, Vienna; one year Polytechnic, Degree; Civil Engineer 1898. Drawing-room, 1901-1903, Garrett, Cromwell Engineering Co., Cleveland, Ohio, on blast furnace and steel works, construction work 1904, American Bridge Co., Chicago. Donora Steel Works, designed several improvements pertaining to the blast furnace and structural departments. 1905, American Steel & Wire Co., Pittsburg, Pa., designed blooming mill engine, improvements to their plate mills. Republic Iron & Steel, Youngstown, O., 1906, designed accessories to two new blast furnaces, etc. Present position, designer on steel works, construction work, Morgan Construction Co.

References: J. C. Cromwell, L, A. Zohe. David Goehr, V. E. Edwards, J. R. George, E. H. Carroll.

GEORGE THEODORE FRANKENBERG

George Theodore Frankenberg, East Columbus, Ohio. Born Columbus, Ohio, 1879. Ohio State University, M.E., 1902. Drawing-room, Columbus Iron and Steel Co., 1902-1904. In charge of construction last six months. Drafting on 84″ plate mill at the La Belle Iron Works, one year, 1905, in charge of drafting room. Ralston Steel Car Co. three months; promoted to mechanical Engineer, which is present position.

References: Wm. T. Magruder, E. A. Hitchcock, F. E. Sanborn Fred W. C. Bailey, Horace Judd.

HARRY GAY

Harry Gay, 39 Ravine Ave., Yonkers, N. Y. Born Sedalia, Mo. University of Mo. two years, Mech. Eng'g. Course and Mathematical course. Apprentice at Bevier, Mo. Northwestern Coal and Mining Co., 1896-1899. Surveying, mapping, engine and pump running. Drawing-room same company. Nov., 1900, Draftsman D. H. Burnham & Co., Archts., 1900-1901. Chicago, Swift & Co., design and construction, 1902-1903. Jan.-Dec., 1903, Chicago, Draftsman with Sargent & Lundy, design of electric power stations. Draftsman P. J. Weber, 1903-1904. Draftsman Purdy & Henderson. Designing Draftsman N. Y. C. & H. R. R. R., 1904-1905, electrical dept. Shop inspector 1905-1906. Resident Inspector construction, Yonkers, N. Y., Power Station, N. Y. C. & H. R. R.R., representing Elec. Dept. of R. R. at site of erection.

References: E. B. Katte, W. S. Monroe, David Lofts. C. G. deNaval, C. Schwartz, H. C. Gardner.

STEWART McCULLOCH MARSHALL

Stewart McCulloch Marshall, Johnstown, Pa., Born Centralia Pennsylvania, June, 1879. B. S. in E. E., University of Pennsylvania, 1900. Squad foreman in mechanical drawing-room, Cambria Steel Co., 1902-1906. Instructor in Mechanical Engineering, University of Pennsylvania, 1900–1902. Steam Engineering Department, Cambria Steel Co., July-December, 1902. Engineer of Tests, Cambria Steel Co., February-November, 1906. Present position, Assistant Chief Engineer, Cambria Steel Co.

References: H. W. Spangler, Joseph Morgan, J. H. Geer, Arthur M. Greene, Jr., Jno. Birkinbine.

HAROLD T. MOORE

Harold T. Moore, 4535 Pulaski Ave., Germantown, Phila., Pa. Born Chester, Pa., 1879. B. S., University of Pennsylvania, 1901; M. E., 1904. Drafting room, Link Belt Engineering Co., Philadelphia, 1901-1903. Other engineering work, Dodge & Day, mechanical, electrical and industrial engineering, design and installation of motor drives, shop and power plant equipment, motor, dynamo and engine tests; supervising of outside construction and erection work, 1903 to present time. Present position, Mechanical Engineer, Dodge & Day.

References: James M. Dodge, H. W. Spangler, Geo. T. Gwilliam, C. E. Machold, C. N. Lauer.

FREDERICK LUCIEN RAY

Frederick Lucien Ray, 598 St. Mary's Street, Borough of Bronx, New York City. Born Indiana, November, 1867. International Correspondence Schools. Engineer, Cambria Mining Co., Cambria, Wyo., 1890–1892. Chief Engineer, Terre Haute Electric Co., Terre Haute, Ind., enlarged and rebuilt plant twice, having supervision of construction of buildings and installation of machinery, 1892–1902. Erecting Engineer, Westinghouse,Church, Kerr & Co., New York City, 1902-1903; erecting work on 500 H.P. Westinghouse marine type engines at Union Depot, Pittsburg, Baldwin Locomotive Works, Philadelphia, and Stanley, Rule & Level Co., New Britain, Conn. Superintendent of Power, Stanley, Rule & Level Co., New Britain, Conn., involving change of heating system, wiring and lighting, 1903–1907. Present position, Superintendent of Construction, W. M. Shuman & Co.

References: A. P. Bolel, Jr., A. W. Stanley, E. S. McClelland, Frank C. Wagner, Henry R. Kent.

FRED. E. ROGERS

Fred. E. Rogers, 6 Garfield Place, E. Orange, N. J. Born Tyrone, N. Y., 1866. Three years Dundee Preparatory School (Dundee, N. Y.), 1890-1894. Apprentice at Corning, N. Y., shops, Fallbrook Railway (now N. Y. C. R. R. under Wm. A. Foster, M. M.), on general locomotive repair work, including air-brake and valve motion work. Shop experience 1890-1899, Fallbrook Ry. Buffalo & Susquehanna R. R. (Galeton, Pa,). under J. D. Campbell, M. M., for a time in practical charge of the valve motion work about 90 locomotives and occupied an advisory position for several years. Emergency man in case of break-down on the road. Present position, editor "Machinery" and "Railway Machinery." Engaged in editorial work exclusive since 1899.

References: F. Richards, C. M. Basford, W. L. Cheney, Oscar E. Perrigo, Frank H. Burton.

JACOB DANIEL SCHAKEL

Jacob Daniel Schakel, Otis Elevator Works, Yonkers, N. Y. Born Amsterdam, Holland, October, 1868. Stankard Institute, Amsterdam, Holland; Daakwyk's Institute, Yselstein, Holland, 2½ years; International Correspondence Schools, Scranton, U. S. A. Machinist and metal worker, C. Schakel's Metal Works, 1885-1889. Drawing-room, C. Schakel, 1889-1890. Babcock & Wilcox, New York, 1893; Otis Elevator Company, Yonkers, N. Y., 1902-1906. Charge and part owner C. Schakel's Metal Works, Amsterdam, 1890-1893. Titsink & Eising, New York City, 1894. L. C. Jandorf & Co., New York City, 1895. A. Smith & Son Carpet Works, Yonkers, machine shop, 1896-1898. Otis Elevator Co., 1898-1902. Present position, Assistant Mechanical Engineer, Otis Elevator Co.

References: O. T. Smith, Allen C. Smith, D. L. Holbrook, W. A. Morse, E. W. Marshall.

DUNCAN G. STANBROUGH

Duncan G. Stanbrough, Department of Yards and Docks, Navy Yard, Norfolk, Va. Born Newburg, N. Y., 1878. Three years Stevens Preparatory School (Hoboken, N. J.); four years Cornell University (Ithaca, N.Y.) M. E., 1904. Gray National Telautograph Co. (New York City), April-Dec., 1904. In

shop assembling Telautographs five weeks, remainder of time in charge of machines in New England with office in Boston. Drawing-room, Electric Boat Co. (Quincy, Mass,). on switchboard design Dec. 1904-May, 1905., Electrical Engineer, Chittenden Power Co., and Rutland St. Ry. Co., May-Aug., 1905. Westinghouse, Church, Kerr & Co. Aug-Dec., 1905. Drafting-room and Superintendent of Construction on remodeling Frederick & Middletown Ry Co.'s, track, power house, and overhead U. S. Navy Yard, Norfolk, Va.; first-class draftsman, preliminary layout 4000 kw., steam-turbopalternator central station including 9000 cu. ft., compressed air equipment. Rated Master Electrician, Navy, 1906, responsible to Civil Engineer, I. S. N., for design, drafting and construction work on central station, transformer equipment, boiler plant for Training Station, underground conduit system, central heating plant. Operating two steam driven light and power plants.

References: Jno. S. Reed, W. F. Durand, T. S. Bailey, R. C. Carpenter, John A. La Fore.

FOR PROMOTION TO ASSOCIATES' GRADE

MAXWELL MAYHEW UPSON

Maxwell Mayhew Upson, Rockville, Conn. Born Milwaukee, Wis., 1876. University N. Dakota, A. B.; Cornell University, M. E., 1899. Apprentice, vacation summers 1895-1897. Operating engineer, threshing and grain elevators. Drawing-room, 1899, Westinghouse, Church, Kerr & Co. 1899-1905, erector, power houses, engineer and general supervisoring engineer Westinghouse, Church, Kerr & Co. Charge of design, purchasing of material and erection of the following works: Westinghouse Machine Co., Attica, N. Y., Westinghouse Electric & Mfg. Co., Newark Plant, Canadian Westinghouse Co.'s Plant, Hamilton, Ont. Present position, Engineer and assistant to the president of Hockanum Mills Co., Secretary of the Minterburn Mills Co.,

Elected a Junior, 1901.

References: Walter C. Kerr, H. H. Westinghouse, Samuel Whinery, W. W. Churchill, R. C. Carpenter, A. W. Smith.

LESTER GODFREY WILSON.

Lester Godfrey Wilson, Norfolk, Va. Born Boston, Mass., 1880. Four years, Columbia, M. E., 1901. Draftsman and assistant designer, Mr. James G. Wilson, 1901-1902. Engineer and draftsman, Jas. G. Wilson Mfg. Co., 1904-1905. Had charge erection of specialities, Long Island and at Palm Beach, 1901-1902. Superintendent, laying 6 acres of patent wood-block floor, Washington, 1902-1903. Engineer and Ass't, manager of works, 1904-1905, charge of erection of special work in the field J. G. W. Mfg. Co. Present position, Engineer J. G. W. Mfg. Co.

Elected Junior, 1903.

References: Admiral G. W. Melville, Hon. W. H. Wiley, Chas. P. Breese, W. B. Upton, W. E. Zimmerman.

TO BE VOTED FOR AS JUNIORS

WALTER JONAS ARMSTRONG

Walter Jonas Armstrong, Draftsman, 319 Buttles Ave., Columbus, O. Born Rome, N. Y., 1883. Cornell University, M. E., 1905. Apprentice Electric Co. (Schenectady, N. Y.) Controller Dept., July-Sept., 1904. Drawing-room,

Robins Conveying Belt Co., 1905-1906. Jeffrey Mfg. Co. (Columbus, O.), conveying and mining machinery. Shop exeprience, Fairbanks Morse Mfg. Co., (Beloit, Wis.), Aug.-Oct., 1905. Present position, Draftsman with Jeffrey Mfg. Co., (Columbus O.).

References: A. W. Smith, W. N. Bernard, R. D. Van Valkenburgh, A. T. Bruegel.

EGMONT BENJAMIN ARNOLD.

Egmont Benjamin Arnold, 462 Van Buren St., Milwaukee, Wis. Born Ann Harbor, Mich., 1881. University of Michigan, B. S., 1904. Machinist and erecting machinery Power & Mining Machinery Co., Cudahy, Wis., 1904-1905. Drawing-room Power & Mining Machinery Co., 1905-1906. Shop experience, Power & Mining Machinery Co., 1904-1905. Present position Salesman and Sales Engineer, estimating plants for mining and cement machinery.

References: M. E. Cooley, J. R. Allen, Norman D. Fraser.

WALTER BIXBY

Walter Bixby, Brainard Street, Hyde Park, Mass. Born So. Boston, Mass., March, 1885. Mechanic Arts High School, 3 years; Lowell Institute, night school; Ind. Foreman, Boston, 3 years. B. F. Sturtevant Co., Hyde Park, detail drawings for engine parts, 1903-1904. F. W. Bird & Son, Walpole, Mass., laying out shafts, designing automatic machinery, 1905 to date. Surveying, charge of construction of new shops, F. W. Bird & Son.

References: Edward F. Miller, Peter Schwamb, Walter B. Snow.

JAMES T. BOURQUIN

James T. Bourquin, 974 Brush Street, Detroit, Mich. Born Detroit, Mich., April, 1878. B. S. (M. E.) University of Michigan, 1904. Olds Motor Works, Lansing, Mich., July-December, 1905. Machinist, erecting and machine shop work, Brooks Schenectady and Cook Locomotive Works, 1900-1902. Experimental Department, Olds Motor Works, B. H. P. tests, oil and gasolene analysis strength of materials 1904. Experimental Dept., Peerless Motor Co., Cleveland, Jan.-July, 1905. Olds Motor Works 1906-1907, charge of testing and inspection. Present position, E. R. Thomas Co., Detroit, Foreman and Inspector.

References: Jno. R. Allen, M. E. Cooley, W. L. Migett.

J. ANSEL BROOKS

J. Ansel Brooks, Brown University, Providence, R. I. Born Worcester, Mass., April, 1876. Ph.B., 1898, M. E., 1900, Sheffield Scientific School. Draughtroom, Driggs, Seabury Gun and Ammunition Co., Derby, Conn., March-Sept., 1898. Stanley Instrument Co., May-September. Teaching Sheffield Scientific School, 1898-1902. Gilbert & Barker Mfg. Co., Boston, one year. Brown University, 1903 to present. Present position, Assistant Professor of Mechanics and Mechanical Drawing, Brown University.

References: E. H. Lockwood, C. B. Richards, Wm. H. Kenerson.

HARVEY MORTON COALE

Harvey Morton Coale, P. O. Box 302, Ardmore, Pa. Born Baltimore, Md., 1882. Cornell University, M.E., 1904. Drawing-room, Chesapeake & Potomac Telephone Co., 1903. Shop experience, The Crown Cork & Seal Co., Baltimore,

Md. Summer shop work in forge shop foundry, machine shop three summers. Erecting engineer York Mfg. Co., York, Pa., June–Sept., 1904. Assisted in erection of two plants in Baltimore, in charge of erecting plant in Philadelphia. Draughtsman The Autocar Co., 1904-1905. In charge of experimental work, 1905-1906. Present position Assistant Chief Engineer the Autocar Co.

References: H. A. Gillis, A. L. Goddard, R. L. Shipman, W. E. Lindsay.

GEORGE EMERSON CROFOOT

George Emerson Crofoot, University of Pennsylvania, Philadelphia, Pa. Born at Painesville, Lake Co., Ohio, 1879. B. S. in M. E., Purdue University, 1905. Instructor in Mechanical Engineering the University of Penn., 1905 to date.

References: W. F. M. Goss, H. W. Spangler, M. J. Golden, L. V. Ludy.

ROBERT HENRY CUNNINGHAM, JR.

Robert Henry Cunningham, Jr., New York City. Born Mt. Sterling, Ohio, 1883. Ohio State University, M. E., 1905. Drawing-room at Delaware, O., Columbus and Pittsburg C. D. M. Elec. Ry. Jeffrey Mfg. Co. American Bridge. Co. Summer vacations 1901-1904 shop experience Cleveland, Ohio. Variety Iron Works, summer of 1900. Saleman Ingersoll-Rand Co.

References: G. R. Murray, W. T. Magruder, E. A. Hitchcock.

ALFRED C. DANKS

Alfred C. Danks, 331 West Street, Wilkinsburg, Pa. Born Newport, Ky., February, 1879. High school, Arkansas City, Kansas. Draughting-room, Muncie (Ind.), Foundry and Machine Co. one year. Inland Steel Co., Indiana Harbor, Ind., one year. Power and Mining Machinery Co., Cudahy, Wis., six months. Shop, Illinois Steel Co., 9 months. Muncie Foundry and Machine Co., two years. Assistant to Engineer in charge of installing bar mill, there in charge. Power and Mining Machinery Co., charge of new construction work on new plant, installation of foundry and entire work of installing gas engine and producer power house. Foreman of erection on road, Westinghouse Machine Co. In charge of experimental gas engine intallation at Edgar Thomson Works, as Manager. Present position, in charge of Gas Engine Dept., Edgar Thomson Works of Carnegie Steel Co., Braddock, Pa.

References: J. C. Cromwell, Arthur West, C. E. Sargent.

ARTHUR MALCOLM DEAN

Arthur Malcolm Dean, Maryland Ave., Hagerstown, Md. Born October, 1883. S. B., Mass. Institute Technology, 1905. Shop, in charge of automobile work, Pope Mfg. Co., Hagerstown. Present position, Assistant Superintendent Pope Mfg. Co.

References: Peter Schwamb, Gaetano Lanza, Edw. F. Miller.

HENRY BERNARD DIRKS

Henry Bernard Dirks, Urbana, Ill. Born Chicago, Ill., 1884. University of Illinois, M. E., 1905. Drawing-room, July-Sept., 1903. Featherstone Foundry and Machine Co., Chicago, Ill. U. S. Geological Survey Coal Tests, St. Louis, July-Sept., 1904. Investigation and tests of High-speed tool steels, reported Bulletin No. 2 "Tests of High-Speed Tool Steel Cast Iron." Present position,

Assistant in Mechanical Technology, Engineering Experiment Station, University of Illinois.

References: L. P. Breckenridge, Morgan Brooks, D. I. Randall.

ARTHUR T. DOUD

ARTHUR T. DOUD, 64 West 107th Street, New York City. Born Winona, Minn., July, 1879. B. S. M. E., Purdue University, 1903. C. B. & Q. Ry., summer and fall 1903, locomotive repair work. C. & N. W. Ry., as machinist helper, etc., 15 mos., during vacations and 1900. Draughting-room, The Arnold Co., Chicago, 1903-1904. L. H. Prentice Co., New York City, 1904-1905. Marwick, Mitchell & Co., New York City, 1905-1906, as Engineer, reporting on condition of manufacturing plants and improving shop and cost systems. Present position, Engineer with Gunn, Richards & Co., production and industrial engineering.

References: W. F. M. Goss, Wm. P. Turner, J. D. Hoffman, M. J. Golden.

EMIL GUSTAV DUDEN

EMIL GUSTAV DUDEN, Oakmont, Pa. Born Germany, March, 1879. Hersfeld Gymnasium, Germany, 5 years; DePauw College, New Albany, Ind., 1 year. B. S., Purdue, 1904. Erecting and testing department, Atlas Engine Works, Indianapolis, Ind., 1899-1900, assembling and testing engines. Draughting-room, T. Silvius, Patent Attorney, Indianapolis, 1898, May-Nov. W. B. Scaife & Sons, Jany.-April, 1905. Shop, Kingan & Co., Indianapolis, May-June, 1899. Deane Bros. Steam Pump Works, Indianapolis, June-Sept., 1902, assembling and testing steam pumps. Atlas Engine Works, June-Sept., 1903, assembling and testing engines. Erecting Engineer, Wm. B. Scaife & Sons Co., Pittsburg, 1904-1905. Present position, Chief Engineer, water purifying and gravity filter department, W. B. Scaife & Sons Co.

References: L. V. Ludy, J. D. Hoffman, W. F. M. Goss, M. J. Golden.

HARRY A. DUNN

HARRY A. DUNN, 163 Prospect Street, E. Orange, N. J. Born Lockland, Ohio, Nov., 1883. Two years Stevens Institute. C. H. Jaeger & Co., Leipsic, Germany 1904-1905, construction of centrifugal pumps. Drawing-room, C. H. Jaeger & Co., six months. Henry R. Worthington, foundry, summer of 1901, 1902, 1903. Present position, Manager Centrifugal Dept., Henry R. Worthington.

References: Geo. J. Foran, Walter Laidlaw, Carl G. DeLaval, Wm. Schwanhausser.

EDWARD R. FEICHT

EDWARD R. FEICHT, 125 Court Street, Dayton, O. Born Dayton, Ohio, August 1881. Ohio State University, M. E., 1904. Stillwell-Bierce & Smith-Vaile Co., machinists' helper, 1903. Westinghouse Machine Co., on erection and test floors for steam turbines, 1904-1905. In charge of erection Westinghouse Parsons Steam Turbines Cleveland, Utica, Detroit, Monroe, Mich., &c. Present position, Erecting Engineer.

References: F. E. Sanborn, E. A. Hitchcock, W. T. Magruder, Francis Hodgkinson.

HENRY DONALD FISHER

HENRY DONALD FISHER, 1234 Callowhill St., Phila., Pa. Born Philadelphia, Pa,. Aug., 1882. B. S. in M. E. University of Pennsylvania, 1904. Assistant to

Mr. John Forbes, Forbes Co., Phila., Pa., general experimental work on inventions, including designing, making patterns and tools for manufacture, 1904-1906. Parker Boiler Co., Phila., Pa., classifying data and experimental work, May to Sept., 1906. Forbes Co., Sept., 1906 to date. Present position, Engineer and Chief Draftsman, Forbes Company.

References: H. W. Spangler, J. C. Parker, A. M. Greene, Jr.

STERLING DeWITT FOWLER

Sterling Dewitt Fowler, State College, Center Co., Pa. Born Berwick, Columbia Co., Pa., June, 1881. B. S. in M. E., Pa. State College, 1906. Shop, American Car & Foundry Co., June to Sept., 1903. Pennsylvania State College Mechanical Laboratories, 1904; Instructor, 1905: given full charge of all Junior laboratory work, conducted recitations in steam engines, boilers and strength of materials, Senior experiments in Mechanical laboratories and full charge of four Senior sections, 1905-1907. Charge of Corliss engines, pumps, boilers, air compressors, etc., past three years. Present position, Instructor at the Pennsylvania State College.

References: B. A. Lenfest, L. E. Reber, J. P. Jackson, H. F. Glenn, C. L. Griffin.

DAVID ROSS FRASER

David Ross Fraser, 1291 Washington Boulevard, Chicago, Ill. Born Chicago, Ill., 1883. Four years at Lewis Institute, Chicago. University of Michigan, B. S. 1904. Drafting on gas producers and gas engines 1904 and 1905, Power & Mining Machinery Co. (Cudahy, Wis.). Blacksmith, Chicago, Portland, Cement Co. (Oglesby, Ill.), summer 1904. Power & Mining Machinery Co. (Cudahy, Wis.), gas engine and power producer test work, 1904-1907. Present position, Chicago, Portland Cement Co. (Oglesby, Ill.)

References: J. R. Allen, N. D. Fraser, M. E. Cooley.

EDWIN G. GREENMAN

Edwin G. Greenman, care of The Lunkenheimer Co., 1536 Waverly Ave., Cinn., Ohio. Born Taylorville, Ill., 1881. B. S. in M. E., University of Illinois, 1902. Apprentice, Allis-Chamber Co., Milwaukee, Wis., July to Oct., 1902. Drawing-room, Port Huron Engine and Thresher Co., Port Huron, Mich., engine details, June-Sept., 1901. Champaign & Urbana St. Ry. Co., Champaign, Ill., erecting engines and boilers, June to Oct., 1903. Instructor Mechanical engineering, University of Ill., 1902-1903. University of Cincinnati, complete charge of machine design and mechanical laboratory, 1903-1904. Draftsman with The Lunkenheimer Co., designed new furnace building, laid fire protection reservoir and pump room and power plant addition, 1904-1905. Present position, Chief Draftsman, The Lunkenheimer Co.

References: L. P. Breckenridge, H. Ritter, D. T. Randall.

ROGER WOLCOTT GRISWOLD

Roger Wolcott Griswold, Erie, Pa. Born Erie, Pa., 1879. Ph.B., Sheffield Scientific School, 1902. Apprentice, The Griswold Mfg. Co., Erie, Pa., foundry and machine work. Drawing room, 1903-1904; Foundry and Machine shop, 1902-1903. Present position, Vice President and superintendent The Griswold Mfg. Co.

References: C. B. Richards, E. H. Lockwood, Alex, Jarecki. E. J. Armstrong.

FREDERICK WILLIAM HACKSTAFF

Frederick William Hackstaff, New York City. Born St. Louis, Mo., 1882. M. E. Cornell University, 1905. Drawing-room, general designing and drawing, Rockwell Engineering Compay, summers 1902-1903 and 6 months 1903. Shop experience, general mill work American Manufacturing Company, Brooklyn, 1905-1906. Present position, Manager of Transmission Rope Department, American Manufacturing Company.

References: William F. Morgan, Albert W. Smith, Robert L. Shipman, Judson H. Boughton.

DAVID CLAYTON JOHNSON

David Clayton Johnson, 245 Hewes St., Brooklyn, N. Y. Born Brooklyn, N. Y., 1885. M. E. Stevens Institute, 1906. Assistant Engineer H. deB. Parsons, 1906 to date.

References: H. deB. Parsons. David S. Jacobus, James E. Denton, H. B. Atkins.

GROVER CLEVELAND LUCKER

Grover Cleveland Lucker, St. Marks Hotel, N. Y. Born New York, 1884. Cornell University. M. E., 1906. Special apprentice Ingersoll-Rand Co., Easton, Pa., Phillispburg, N. Y. Present position, Agent same company.

References: A. W. Smith, T. M. Gardner, D. S. Kimball, R. C. Carpenter, H. D. Hess.

ROBERT WALTER McLEAN

Robert Walter McLean, Massachusetts Institute of Technology, Boston, Mass. Born Malden, Mass., August, 1880. S. B. Massachusetts Institute of Technology, 1905 (Mech, Eng.) Present position, Instructor Mass. Inst. of Tech. (teaching steam engineering).

References: Edwin F. Miller, Peter Schwamb, Gaetano Lanza.

HORACE JAMES MACINTIRE

Horace James Macintire. Born at Ft. Worth, Texas 1880. S. B. Mass. Inst. of Technology, 1905. Drawing-room, Blake Pump Works, East Cambridge, Mass., summer 1905, detail drafting. Shop experience, United Shoe Machine Co., Winchester, Mass., summer 1904, machinist. Timekeeper and sub-foreman, Albertha w Const. Co., Attleboro, Mass., summer 1906. Present position, Assistant Instructor Mass. Institute of Technology.

References: E. F. Miller, G. Lanza, Peter Schwamb.

JOHN MAGEE

John Magee, Hamilton, Montana. Born at Chelsea, Mass., 1879. Three years Mass. Inst. Tech. Apprentice, drawing-room, shop experience, and various positions including Asst. Supt. for three years and Supt. and Secretary for two years Magee Furnace Co., 1898-1906. Am. Foundry Ass'n, Vice-President; N. E. Foundry Ass'n, President. Present position, Engineer in charge of construction Bitter Root District Irrigation Co.

References: Paul R. Brooks, Thos. Cunningham, Walter B. Snow, Richard Moldenke.

SUMNER MARSHALL MANLEY

Sumner Marshall Manley, Kansas City, Kansas. Born Brockton, Mass., 1878. Mass. Inst. Tech., S. B., 1900. Drawing-room (Providence, R. J., Silver Spring Bleachery, 1900-1903. Shop experience, Providence, R. I., Silver Spring Bleachery, 1903-1904. Asst. in Mechanical Dept. Kansas State Agricultural College, Jan. to July, 1904. July, 1904, P. & G. Co. Present position, Master mechanic, Proctor & Gamble Co., Kansas City, Kansas.

References: Edward F. Miller, Peter Schwamp, R. S. Woodward.

HENRY ELLSWORTH PAINE

Henry Ellsworth Paine, 63 First Street, San Francisco, Cal. Born at Cleveland, Ohio, 1881. Cornell University, 1906. Apprentice, shop-practice, Wellman, Seaver, Morgan Co. on erecting floor. Drawing-room, Cal. Powder Works, Pinole, Cal. Engineering salesman, Charles C. Moore & Co. present position.

References: R. C. Carpenter, A. W. Smith, D. S. Kimball.

GEORGE D. PETTENGILL

George D. Pettengill, Warsaw, N. Y. Born Warsaw, N. Y., 1880. American School, Armour Inst. of Technology. General drawing-room work, laying out machines, design and details, entering shop orders, etc. Figuring strength and proportions of machine parts. Part of time above spent in construction work. Complete charge of drawings for construction work. Present position, Chief Draftsman, Warsaw Elevator Co.

References: Wm. M. Dollar, J. L. Osgood, David H. Darrin.

GEORGE CHRISTIAN PINGER

George Christian Pinger, Warren, Pa., 509 Market Street. Born at Albuquerque, New Mexico, 1881. Cornell University, 1905. Apprentice at five concerns during respective summer vacations. Drawing-room, E. A. Havens, Peoria, Ill., 1899. Peoria Steam Heating Co., 1900. Acme Harvester Co., 1901. Avery Mfg. Co., 1902, Machinist, Peoria, Ill. 1905-1906, Draftsman Gas Engine Dept., Snow Steam Works, Buffalo, N. Y. Present position, The Bartholemew Company.

References: Albert W. Smith, Clarence N. Scott, R. C. Carpenter, Clay Belsley.

GEORGE FRANKLIN READ, JR.

George Franklin Read, Jr., Fall River, Mass., 32 Lincoln Ave. Born Fall River, Mass., 1880. Worcester Polytechinc Inst., B. S., 1904. Apprentice E. V. Read, covering about 1 year , engaged in general work. Drawing-room and shop, summer of 1903, F. E. Read Co., Worcester, Mass. Journeyman machinist, 1900, Kilburn Lincoln Co. In charge of the Washburn Shops Exhibit, Machinery Hall, World's Fair, 1904-1905. Shop work, 1905-1906, Erecting Engineer, Steam Turbines, etc., Westinghouse Machine Co. Road work, 1906, placing erection, starting and operating steam turbine plants. Direct charge of units ranging from 300 to 1000 Rev. Present position, Chief Inspector of Factory, Fidelity & Casualty Insurance Co., New York City.

References: William W. Bird, Albert Kingsbury, Charles M. Allen.

HAROLD P. RENO

HAROLD P. RENO, Saylesville, R. I. Born Pittsburg, Pa., 1882. Lehigh University, M. E., 1904. Drawing-room, June, 1904-1905 with Philadelphia & Reading Coal & Iron Co.'s Pottsvile shops, Pottsville, Pa., Building and repairing Machinery for the Reading Collieries. Present position, with Mr. H. L. Gantt Sayles' Bleacheries, Saylesville, R. I.

References: H. L. Gantt, J. F. Klein, C. W. Rice, M. L. Cooke, K. F. Wood.

LAWRENCE ROYS

LAWRENCE ROYS, Three Rivers, Mich. Born Saginaw, Mich., 1884. University of Michigan, B. S., in E. E., Michigan, 1906. Apprentice, machine shop, A. F. Bartlett & Co., Saginaw, Mich. Draftsman, Sheffield Car Co., July, 1906, to date. Present position.

References: M. E. Cooley, J. R. Allen, W. L. Wiggett, T. H. Hinchman, Jr.

GEORGE SAMUEL WILSON

GEORGE SAMUEL WILSON, Seattle, Washington, M. E. University of Nebraska, 1906. Born Columbus, Neb., 1880. University of Nebraska, 1906. Apprentice, machinist, Union Pacific R. R. Co., Wyoming, 1898-1902. Drawing-room, July-Sept., 1906. Gas Engine and gas producer work, Fairbanks, Morse & Co., Beloit, Wis. Shop experience, U. P. R. R. Co., Cheyenne, Wyo., 1903-1905, machinist apprentice. Machinist. June-Sept., 1905, Westinghouse Machine Co., East Pittsburg, Pa. Present position, Instructor, Mechanical Engineer, Washington University Seattle, Wash.

References: C. R. Richards, Chas. E. Chowins, Melvin Price

MEMORIAL

CHARLES HARDING LORING

The death of Admiral Charles Harding Loring[1] (Chief Engineer, U. S. Navy, retired) on February 5, 1907, removes a man who had been a prominent figure in engineering circles and in our Society for many years. He was a member of the Society almost from its organization and had filled its highest offices, being a Vice-President in 1885–1887, and President for the term 1891–1892. However great a man's professional ability, his free election to such high offices is a strong testimonial to his worth as a man, and is, indeed, the highest tribute of the personal regard in which he is held by his fellow-members. As will appear in this brief sketch of his life and work, he had filled all the highest offices to which a man in his branch of engineering could aspire, and he had been privileged to take a very active part in furthering the progress of marine engineering.

He was born in Boston, December 26, 1828, and received his education in the public schools of that city. As his educational period was before the day of technical schools, he followed the usual course of preparation for mechanical engineering and served a regular apprenticeship in the machine shop. At its close, in 1851, he entered the navy as a third assistant engineer, attaining, by competitive examination, the highest place in a class of fourteen.

His entrance was just too late to give him an opportunity for participation in the Mexican War, and by the time the Civil War broke out he had passed through all the junior grades and had become a chief engineer. During his service in junior grades he had been laying the foundation for his more important work when an older man and in higher positions, a portion of his shore duty having been as assistant to the engineer-in-chief of the navy, Mr. Samuel Archbold, in which capacity he had charge of the experimental work and tests of engineering devices coming before that office. It is interesting to note

[1] The word regarding the death of Admiral Loring and the invitation of the Council were received just as the Proceedings was going to press, and the Society is appreciative of the courtesy of Mr. Walter M. McFarland in preparing so complete a tribute on such short notice, and also acknowledges the favor of Mr. H. H. Suplee for the photograph reproduced in this number.—Editor.

that while engaged in this duty he made a test of the first injector which came to this country.

During the Civil War he was in active service the whole time and during the first eighteen months was fleet engineer of the North Atlantic Station, being attached to the fine old steamer "Minnesota." He was on board this ship during the attacks of the "Merrimac" on the Northern fleet in Hampton Roads on the eighth and ninth of March, 1862, when the "Cumberland" was sunk and the "Congress" burned and when the "Minnesota" also was attacked.

A little later he was detached from sea duty and sent to Cincinnati to supervise the construction of three river and harbor monitors and also of some light-draught sea monitors building there. Subsequently he was made general inspector of all the iron-clad steamers building west of the Alleghanies, having in charge at one time eleven monitors building at Pittsburg, Cincinnati, and St. Louis.

During the Civil War a number of excellent engines had been accumulated for hulls which were in process of construction, but with the close of the war all work was stopped, and after a time a board was appointed to recommend the best disposition of these engines which were stored in the various navy yards. It was about this time that the compound engine was coming into general use, and the same board was directed to make a study of the compound engine, with a view to its introduction in naval vessels. Of this board Admiral Loring was senior member, and associated with him was the late Chief Engineer, Charles H. Baker.

After a very exhaustive study of the subject, they recommended the introduction of compound engines and the abandonment of the simple form, and the conversion of a number of the engines which were on hand into compound engines. Four sets of these simple engines were so converted and were fitted to the "Vandalia," "Marion," "Quinnebaug," and "Swatara." The tests of these engines were very satisfactory and showed a coal economy for short runs of not much over two pounds of coal per horse-power hour.

This study of the compound engine made it natural that Admiral Loring should be selected as the representative of the Navy Department when, in 1874, he and the late Dr. Charles E. Emery made an elaborate series of trials of the engines of the revenue cutters "Rush," "Dexter," "Dallas," and "Gallatin," to determine by actual test the relative economies of compound and simple engines, designed for the same work in similar hulls, and also to secure reliable and authoritative data with respect to the economy of steam jacketing. These tests were the first of the kind conducted under circumstances of

entire reliability, with the result that the report of the trials was republished all over the world and is still quoted in all the textbooks on steam engineering.

Admiral Loring's next tour of sea duty was as fleet engineer of the Asiatic Station on the U. S. S. "Tennessee," where he had as his chief assistant, George W. Melville, who later became his successor as chief of the Bureau of Steam Engineering. There was nothing specially eventful in this cruise, and at its end, in 1880, he was assigned as the head of the steam engineering department of the New York Navy Yard.

This was the period of greatest inactivity in the history of the navy, and there was little to do, even for a very active man, except routine work. During this tour, however, Admiral Loring was senior member of a board which made a test of the machinery of the "Anthracite," a little yacht with a triple expansion engine working with 600 pounds pressure. The experiments were valuable as showing that, with the form of apparatus on board the "Anthracite," there was no such gain in economy as to warrant the tremendous pressure carried, while it involved numerous practical difficulties.

In 1881 he was a member of what is known as the First Naval Advisory Board, appointed by Secretary Hunt to formulate a shipbuilding program for the navy which he might submit to Congress. The personnel of this advisory board was distinguished in all its branches, and the work they did made possible our splendid fleet of today, as they definitely decided, against strong professional opposition, to abandon wooden hulls for those of iron and steel, and for general progress in every respect. In 1882 he was a member of another important board known as the Navy Yard Board, of which Admiral Luce was senior member. The duty of this board was to visit all the navy yards of the country for the purpose of determining which of them might with advantage and economy be closed. It was a delicate task, but the report, when finally approved, gave general satisfaction, and its recommendations were carried out.

On the retirement of Engineer-in-Chief Shock, only two successors were thought of, one of whom was Admiral Loring, and his merit and thorough qualification for the position were so well recognized that the appointment came to him entirely unsought. This was in 1884, during the administration of President Arthur. Secretary Chandler was presiding over the Navy Department at this time and it was under his supervision that the four vessels, commonly known as the the Roach cruisers, the "Atlanta," "Boston," "Chicago," and "Dolphin," were built.

Part of the scheme of the building of the new navy was the organisation of what was known as an Advisory Board, composed of two civilians and a number of naval officers. Owing to this regime the bureaus were not given the same free hand that has obtained since the Advisory Board was discontinued, although they did valuable work in the details of designs. Forced draught was used on these new vessels, after having been tried on two others—the "Alliance" and "Swatara"—under Admiral Loring's direction.

The change of administration in 1885, when Mr. Whitney came in as Secretary of the Navy, brought additional trouble for Admiral Loring. The Democrats had been so long out of power that they came in prepared to find everything wrong, and there were busybodies to throw out hints and insinuations against Loring. It is probable, too, that he and Whitney were naturally incompatible. Whitney was a nervous pushing man, who wanted everybody around to appear to be hustling. Loring was a man of great dignity with none of the arts of the courtier or politician. Instead of running to Whitney with every detail of his work and thereby becoming, at least, intimately acquainted with him personally, he was content to conduct his work by written reports. He worked just as hard, but Whitney did not appreciate it. The backbiters, who had Whitney's ear (and it is sad to relate that there were naval officers among them), led him to believe that Loring was not abreast of the times or capable of providing the best machinery. Indeed, the attack was upon the whole Engineer Corps, and it is a fact that negotiations had been conducted with a prominent British engineer to come over and do our designing for us. This was only prevented by the law officers pointing out that it violated the contract labor law.

It may be mentioned in this connection that the Anglophiles persuaded the Secretary to buy a number of plans abroad. They were not purchased by experts, with the result that we were undoubtedly "done" in the transaction. It would have been a safer thing to purchase complete ships, which would, at least, have had to make successful trials. The history of the "Texas" is too well known to engineers to need repetition here.

The result of all these conditions was to convince Loring that he did not have Whitney's confidence and that for the sake of his Corps, he had better give up his office as Engineer-in-Chief. Accordingly, in 1887, he tendered his resignation.

After leaving the Bureau of Steam Engineering he was made senior member of the Experimental Board of Naval Officers at the New York Navy Yard, which board, under his direction, conducted many

exceedingly valuable experiments. Among the most important were the competitive tests in 1889 of water-tube boilers to determine the type that should be used on the coast defence vessel "Monterey," and it may be well here to call attention to the fact that this was the first case on record where a boiler had ever been run continuously for twenty-four hours when burning more than fifty pounds of coal per hour per square foot of grate.

Another very important series of experiments conducted by Admiral Loring were those on the boilers of the torpedo-boat "Cushing," to determine the economy of evaporation with different air pressures and rates of combustion. These experiments have proven of the greatest interest, and form a very valuable collection of engineering data. A number of clever devices had to be schemed out to carry on these tests, and the whole success was a great credit to Admiral Loring and the board.

Having reached the age limit in December, 1890, he was placed on the retired list; but having always been a man of very vigorous physique, he did not give up active employment and was for a time consulting engineer to the United States and Brazil Mail Steamship Company. During the late war with Spain he was recalled to active duty and assigned inspector of engineering work in New York.

Admiral Loring was a man of great personal attractiveness and to most of his friends the social side of his character was the more important. They admired the able engineer, but they loved the man. Although a man of great dignity, as has been mentioned, this only repressed undue familiarity, and he was a delightful companion. His keen sense of humor and remarkable skill as a *raconteur* made him a decided acquistion to any company. It was remarked by a brother officer, himself remarkable for his abilities as an entertainer, that Loring was the best "diner out" in the Navy. He wrote well and was a good speaker, doing these with the dignity and elegance which were a part of his nature.

He was President of the Engineers' Club for two years, thus receiving the highest social honor which engineers can confer. His incumbency of the Presidency of our own Society has already been mentioned. He was also a Vice-President of the Society of Naval Architects and Marine Engineers from its organization until his death, and while his health permitted was very active in its council and general meetings. The Army and Navy Club of New York owed much to his active interest, as he had filled most of the offices and was, for a number of years, its Secretary. He was also a member of the Loyal Legion and of the Grand Army of the Republic.

He had grown old gracefully and slowly, so that, although in his seventy-ninth year when he died, he did not look much over sixty. In appearance, there was quite a resemblance to President Cleveland, but as they differed very radically in politics, Admiral Loring did not count this as a special privilege.

In reviewing this life, we are struck with the relatively brief period during which marine engineering has been a practical success. Although his life did not, like that of our beloved Uncle Charley Haswell, cover the whole period, yet Admiral Loring was in personal touch with all the steps of progress, going back to box-boilers and side wheel engines and coming down to water-tube boilers, forced drafts, triple expansion engine, and the steam turbine. In nearly all of these he had an active and sometimes an important part, so that he could justly feel that he had not only done his duty but had been a factor in the advancement of the profession and the service he loved so well.

DISCUSSION

THE ART OF CUTTING METALS

By F. W. Taylor, Published in Mid-November Proceedings

Mr. H. C. H. Carpenter Mr. Taylor's valuable work on "The Art of Cutting Metals" will rank among the most remarkable practical scientific researches ever published. An investigation which has extended over 26 years, which has been rendered possible by the collaboration of five men, each of whom appears to have possessed a special qualification for some one branch of this many sided work, and the account of which is based on some fifty thousand recorded experiments, is probably without a parallel. The ground covered is so extensive that it is almost impossible for any one man to form anything like an adequate judgment of the research as a whole. The most that can be attempted is an estimate of that portion in which a writer may have special experience.

2 The history of the evolution of the art of cutting metals during the last 26 years set forth by Mr. Taylor has appealed to the writer with special interest. It is one of the comparatively rare instances in which results of the highest importance have been reached only after long years of patient grappling with difficulties of the most intricate and baffling character and in which the number of "independent variables" has bewildered the most powerful intellects. This quality places it among those types of research whose problems are only solved by the "patient intending of the mind."

3 Mr. Taylor has courteously referred, and indeed given great prominence, to two investigations of the writer's which bear upon "the art of cutting metals," and the latter would like to take this opportunity of expressing his gratification both for the value attached to them by so eminent an authority, and for the substantial correctness with which they have been interpreted. A few minor corrections are however necessary, and these will be dealt with at once.

a "Cementite" is said to be the technical term for hardening carbon. This is not correct. The technical name for the structure of steels containing hardening carbon is either "Martensite" or "Hardenite." Cementite, although a *hard* carbide of

iron (Fe_3C), occurs in softened steels containing more than 0.90 per cent of carbon.

b The temperature at which hardening changes to softening carbon on cooling is stated to be 760° C. This is rather too high for most steels. For pure carbon steels it is about 700°–720° C. For special steels, e.g., the chromium or chromium tungsten steels, it varies between about 710°–760°.

c Mr. Taylor's reading of the significance of the changes of slope of the curves in reference to critical changes is correct. But within wide limits the general character of the curves is independent of the rapidity with which the heating and cooling takes place, and this is one of the chief advantages of the differential over the direct method of taking such curves. In the former method the alloy is cooled against a neutral metal or alloy which is known to give a smooth cooling curve; in the latter the alloy is cooled against time. The former, in addition to being much more sensitive, is also more philosophical.

d The writer does not agree with Mr. Taylor's statement as to the inferiority of Dr. Matthews' steel as compared with recognized high speed steels in the cutting tests. Although the former did not stand up to its work in machining hard steel, it behaved extremely well in cutting medium hard steel, and on the whole, satisfactorily in machining soft steel. It was tested under less advantageous conditions than the tools in the Manchester tests. And it seems fairer to suspend judgment unless further tests are made.

e Reference must be made to the following quotation from Mr. Taylor's address: "Our original investigations showed that red hardness was seriously impaired by heating tools above 1200° F. (650° C.), and that the quality of red hardness was entirely removed by heating them up to 3150° F. (730° C.). Now it will be noted that neither in the heating nor cooling curves shown by Professor Carpenter any critical point is shown at these temperatures which are the critical temperatures so far as we know for high speed steels, and therefore the critical temperatures affecting red hardness." The heating, but not the cooling, curves bear on this point. Alloy No. 14 shows no break in the curve, but Alloy No. 16, previously cooled from1200° C., shows a change of slope at about 622°, which is continued until 735° C. This is almost exactly the range referred to by Mr. Taylor. And if the other curves in

the paper ("Journal of the Iron and Steel Institute," 1905) are consulted it will be noticed that some of them give similar breaks. Accordingly, it is the writer's view that the curves are more in agreement with the results of practical tests than Mr. Taylor has given them credit for.

4 Before discussing a few of the extremely interesting issues raised in the address, it appears desirable to take note of the following important conclusion arrived at by Mr. Taylor: "All of these facts indicate clearly that the methods as yet devised by scientists for determining the most important quality (*i. e.*, red hardness) in the new high speed steels are ineffective." When such a statement is made with a wealth of practical experience and experimental results behind it, the safest course is to accept it without demur. Probably no one who studies this research will challenge Mr. Taylor's conclusion that the only reliable guide or index to the behavior of cutting tools hitherto devised consists in making standard cutting speed tests. But as one of the scientists referred to, the writer would like to state that his aim in undertaking researches and contributing papers in the field was far less ambitious than that of supplying a simple and reliable index to the property of "red hardness," being, viz: initially an attempt to arrive at the rationale of the heat treatment of high speed tool steels in current use.

5 A point of the utmost importance is the distinction drawn by Mr. Taylor between "hardness" and "red hardness." This point is labored with considerable emphasis in various passages, but the following quotation will suffice to define his position. "He," *i. e.*, the writer, "has failed to recognize the existence of 'red hardness' as a property of these steels entirely independent of hardness. We would again call attention to the fact that the highest degree of 'red hardness' can be found in these high speed steels when accompanied either by the highest degree of hardness on the one hand, or by a very considerable degree of softness on the other hand." If the writer has understood Mr. Taylor correctly, he draws a sharp distinction between the hardness in virtue of which a tool cuts at the ordinary or comparatively low temperature, and the hardness in virtue of which a high speed steel cuts at a red heat (red hardness).

6 This may be true, but the following considerations appear to indicate that the facts observed and recorded by Mr. Taylor and his co-experimenters can also be explained without assuming a difference of property. The writer is well aware that the simplest explanation is not always the true one, but until it has been shown to be wrong there is no need to have recourse to a complex one involving rash assump-

tions. Time unfortunately prevents him from developing the explanation to the extent it really requires to bring it into line with the numerous facts marshalled by Mr. Taylor in support of his view, but the following general exposition may be sufficient to enable application to be made to particular cases.

7 The relations between carbon and iron must first be considered. The most complete state of mutual solution of these elements appears to correspond to austenite (white polyhedra); the next, to martensite (acicular structure); the next, to the varieties of sorbite (almost structureless), and the least, to pearlite (banded structure). In practice, pure austenite has never been obtained. The method adopted for keeping the elements in solution, viz: quenching in various media is not sufficiently rapid to prevent some of the carbon (in what form is immaterial) from separating, and the result is a mixture of austenite and martensite. In pure carbon tool steels the hardening is carried out in such a way that as far as possible the iron and carbon are in the form of martensite. This is the hardest modification obtainable. If an attempt is made to cut work at a high speed with such a tool, it fails because the martensite changes rapidly at 200°–300° C. into the sorbite varieties, and ultimately into pearlite, which are all soft.

8 But the addition of tungsten and chromium in the proportions present in high speed steels enables the complete solution of iron and carbon to be maintained by rapid cooling from 1200° C. below 620° C. (1150° F.) and the result is that such steels, as treated for cutting, possess the austenitic structure. As Mr. Taylor points out, the steels in this condition can readily be filed by ordinary hardened tool steel. The reason for this is well known; viz: that austenite can be indented by martensite.

9 What happens when these high speed austenitic tools are put to cut work? The best of them are unaffected by temperatures not exceeding 500°–550° C., the reason being that the chromium and tungsten combined prevent the complete drawing of the temper which takes place in pure carbon steels. Somewhere about 600° C. the austenitic changes to the martensitic structure. *This is the red heat at which the tools cut best.* At higher temperatures the martensitic is replaced by softer materials and the tools break down. According to this explanation the high speed steel possesses at about 550°–600° C. the same hardness that the pure carbon steel possesses at ordinary temperatures. And no distinction seems necessary other than that the hardness is manifested at different temperatures. The hardness itself is the same in the two cases.

10 There is one weak spot in this explanation, viz: the writer has examined cases in which no martensitic structure appeared to be formed from the austenitic structure. Either the tempering proceeded on other lines or the martensite stage was missed. Accordingly he does not wish to press the above exposition, but rather to suggest it as a possible coördination of the facts recorded by Mr. Taylor.

11 It has the merit of offering an explanation of the curious fact mentioned, that "if the percentage of tungsten is increased much beyond 19 per cent, even although the chromium is also increased in quantity, the tool diminishes in red hardness." It is well known, through the work of M. L. Guillet, that the alloy steels with austenitic structure vary considerably in the ease with which they pass into the martensitic stage, and indeed that some of them do not pass at all, and it appears to the writer that No. 14 tool containing 24.64 per cent of tungsten and 7.02 per cent of chromium, may be one of these, in which case the reason for its inferiority of cutting properties is clear, viz: because the martensitic, *i. e.*, hardest structure, is never formed.

12 Mr. Taylor's statement that the red hardness of high speed steels is practically independent of carbon between the limits of 0.32 and 1.28 per cent, is a fresh piece of the kind of evidence that has been accumulating during recent years that carbon can no longer enjoy the unique position as a hardening agent it has been hitherto supposed to possess. It follows clearly from his experiments that in high speed steels the capacity to cut work at a red heat results from a combination of variables, more especially carbon, chromium, and tungsten, in which it is impossible to assign a more important function to one variable than to any of the others.

13 This leads up to what the writer regards as the most baffling question that arises out of that section of the address entitled "Investigations made to find an explanation or theory for the phenomena connected with chromium tungsten tool steels," viz: what is the part played by chromium in high speed steels? As a result of the first of his researches quoted by Mr. Taylor ("Journal of the Iron and Steel Institute," 1905, 433-473), the writer was enabled to conclude that the rationale of the advantageous presence of tungsten in these steels is fairly evident; viz: that its action consisted in altogether preventing under suitably chosen conditions changes in iron carbon alloys which would have for their result the softening of the material and its consequent unfitness for use; and, further, that it imparts to such steels a high resistance to tempering. On the other hand, it was shown that chromium not only does not retard but actually hastens

the conversion of hardening to softening carbon on cooling, and the microscopic evidence was all against the hypothesis of special chromium carbides or double carbides. In other words, the action of chromium was shown to be the opposite to that of tungsten. The question naturally presents itself, "What is the part played by an element which by itself appears to act in a direction diametrically opposite to that desired?"

14 In formulating the view that chromium and tungsten differ fundamentally in their action, the writer found himself in opposition to the current view, viz., that chromium and tungsten acted similarly. The peculiar action of chromium is, however, now recognized by Mr. Taylor. He shows that the Mushet self-hardening steels (1894–1900) which contained tungsten, manganese, and silicon as their principal alloy elements, were different from the present day high speed steels containing tungsten and chromium (tungsten and manganese both act as retarders of critical changes; *i. e.*, similarly); and he emphasizes the difference between chromium and manganese in the passage "*Chromium is the element which in combination with tungsten produces the new quality of red hardness and not manganese.*" The distinction between the actions of chromium and tungsten is drawn in the passage: "A tool without chromium or with very low chromium, even though there is a proper percentage of tungsten present, does not produce a high speed steel even though the manganese be very low or very high."

15 The writer's attempt to coördinate hardness and red hardness in preceding paragraphs permits of application to the present question, as Mr. Taylor shows, even high tungsten steels are not high speed steels. Let it be supposed that these are austenitic steels of the non-transformable type (in which case they will not exhibit red hardness). Now let chromium be introduced. Its tendency will be to convert such steels into transformable ones because it has been shown to hasten the conversion of hardening carbon. In small quantities its influence may be insufficient to bring about the change, but it may be that in considerable quantity (such as the 5 per cent to 6 per cent mentioned by Mr. Taylor) it will cause the change from austenitic to martensitic structure at about 550°–600° C. The result will be a high speed steel possessing red hardness This view can readily be put to the test of experiment, and the writer hopes to undertake this soon.

16 It appears possible to put forward now a scientific classification of the various types of cutting tools. Mr. Taylor groups them

historically under three main heads, which will serve quite well for the writer's grouping, viz:

a The era of carbon tools (up to 1894).

b The era of Mushet or self-hardening tools (1894–1900)

c The era of high speed steels (1900 up to the present time)

Group a represents tools which, in virtue of the treatment to which they are exposed, exhibit maximum hardness at the ordinary temperature. They are martensitic steels. Run at about 200° C. they soften, because at this temperature the martensite changes into sorbite, and ultimately pearlite. The rate of change is at a maximum in these steels.

Group *b* also represents similar tools of martensitic structure but the tungsten retards the rate of change of the martensitic constituent, and hence they can be used at higher temperatures than those in group *a*. Such tools, however, cannot be run at temperatures much exceeding 300°–400° C.

Group *c* includes tools which, after heat treatment, do *not* exhibit maximum hardness at the ordinary temperature. Their structure is austenitic; they can be filed by the tools classified in groups *a* and *b*. In virtue more particularly of their chromium contents, the change from austenitic to martensitic structure takes place at temperatures between 550° and 650° C, and consequently the tools possess maximum cutting hardness at these temperatures. This is the explanation of their characteristic property of red hardness.

17 There is no reason for supposing that group *c* represents the final word in regard to the maximum temperature at which high speed steels can be run. On the contrary, Mr. Taylor's address contains internal evidence that his latest tools can be run at higher temperatures than had been previously reached. A particular combination of chromium and tungsten or other elements may enable the temperature to be pushed up to 700° C. M. H. Le Chatelier has advanced sound theoretical reasons for supposing (at any rate as long as carbon forms an integral part of tool steel) that this temperature cannot be exceeded, because the rate of change is a maximum at 750° or thereabouts.

18 It may be very difficult to make this advance, and the writer is inclined to agree with what he takes to be Mr. Taylor's forecast of the economic future of this industry; viz., that it will probably pay better to produce tools from cheaper materials than those now used that will run at the present degree of temperature than to experi-

ment with costly alloys that may be found to work at rather higher temperatures.

MR. FRED. M. OSBORN Probably the most interesting part of Mr. Taylor's paper to steel metallurgists is the tables and comments dealing with the way in which steel is influenced by varying proportions of certain special elements. While Mr. Taylor's general arguments appear reasonable, it would have been more useful if the deductions had been drawn from a series of analyses identical except so far as concerns the special element under consideration. The other groups of analyses are most complete and interesting.

2 As my work in the capacity of a director of Samuel Osborn & Company, Limited, is particularly connected with the manufacture of the original Mushet steel and its later development, Mushet High-speed Steel, and the former takes such an important place in Mr. Taylor's pap r, the following brief statement regarding Mushet's discovery may be of interest.[1]

ALLOY STEELS

3 It is interesting to note that while Mushet was experimenting in 1868, he found that one of his trial bars had the property of becoming hard[2] after being heated, without the hitherto necessary water quenching. The element which gave the steel this property was tungsten. Mushet began to make and sell this self-hardening steel for lathe and planing tools: and "R. Mushet's Special Steel," as it was called, soon became famous. He was not successful in his business. After some three years he got into touch with the late Samuel Osborn of Sheffield, who in 1871 took over the Mushet process of making crucible and self hardening steels and introduced them, as their qualities and capabilities became known, into nearly every engineering workshop in the world. Tools of Mushet steel were naturally hard but it is believed that the late Mr. Henry Gladwin, who had assisted Mr. Osborn, was the earliest to show that a much better result was obtainable if the cutting portion was reheated after forging and cooled in an air blast.

4 It should be explained that Mr. Gladwin had introduced Mushet steel into the works and trained the blacksmiths in its working, and he found that tools which had been laid on the ground and cooled by the draught of air from under a door gave better results. It was

[1] This statement was read by me before a Society of Engineers two days only before I received the advance proof of Mr. Taylor's paper.

[2] See also "Iron and Steel Institute Journal," No. 2, 1904, pp. 177–78.

later proved that tools which were reheated to a full scaling, or almost yellow heat, did even better work. It was difficult, however, to get the smiths to do this, and in the days before the introduction of high speed steels, principals and managers took little interest in the heat treatment and working of cutting tools.

5 The introduction of Mushet steel enabled engineers to double and triple the output from their lathes, as the tools could both cut quicker and last much longer than those made of carbon steel. This steel was generally adopted and gradual improvements were effected, but a marked advance was made in 1900, when the Taylor-White discovery of a quicker cutting steel was announced to the world.

6 This was not really a discovery of a new heat treatment, nor of a new alloy or mixture. It was really a step beyond the one just described. The editor of the "Iron and Steel Magazine" takes this view, when he says in referring to the sometimes supposed distinction between ordinary self hardening Mushet steel and those special steels known as high speed steels:

> To us it seems, however, that no such distinction can be made between these two varieties of steels. Mr. Metcalf himself says that the discovery of high speed steel resulted from the overheating (possibly accidental) of some ordinary self hardening steel. This treatment, which had hitherto been considered ruinous when applied to self hardening steel resulted in imparting to it those wonderful high speed qualities now so well known. By this treatment the self hardening steel was converted into high speed steel We want no more conclusive evidence of the fact that no sharp demarcation can be drawn between self hardening and high speed steel. It may be that as at present manufactured, the high speed steel differs materially in composition from Mushet self hardening steel. It may be that the proportion of tungsten has been increased and that of manganese lowered, or that in some brands the tungsten has been replaced by molybdenum. The fact remains, nevertheless, that to all tungsten steels of the self hardening variety, if properly treated, high speed qualities may be imparted. By altering the composition, as pointed out, these high speed qualities may be intensified, but the difference between the two varieties of steels remains at best one of degree, not of kind.

7 Again M. Le Chatelier in his paper "Les Aciers Rapides et Outils," speaking of the Taylor-White process, says:

> One has often heard that this discovery was simply a chance: a workman had by negligence heated to a high temperature a tool of Mushet steel, and contrary to what one would have believed, this abnormal treatment made it much better.

8 Here M. Le Chatelier makes it clear that the Taylor-White discovery was a *process* and not a new mixture. At the same time it should be clearly understood that the new high temperature hardening of the last few years for high speed steels has led to constant varia-

tions and improvements in the mixtures. Those who have carefully watched results, and followed up clues have made very considerable progress, so that now high speed steel is made and used for a variety of tools, drills, milling cutters, etc.

9 The following instructions were issued and circulated by my company before the general introduction of high speed steels:

"To obtain improved feeds and speeds R. Mushet's special steel (self hardening) should be heated *gradually* but *thoroughly*, so as to be quite ductile. The tools should then be forged at a *good heat.* Avoid forging it too cold. When forged the cutting end of tool should be *reheated to a good scaling heat*, and then, if possible, *blown cold.* While hot this steel must be kept from water."

10 This circular merely reproduced in printed form the verbal instructions given for years previously by their experts, who visited the engineering shops, showing the smiths how to *heat-harden* and *air-cool* Mushet tools, so that there were few smiths that did not use this improved process. The issue of printed instructions was for a long time avoided, as such instructions would have fallen into the hands of imitators of Mushet steel, and thus given them the opportunity of bringing their products nearer in quality to the original. This point, namely, the leveling effect which heat treatment has on steels of different compositions, is emphasized by Mr. Taylor in his paper.

11 In nearly all recent trials of lathe tools, such as the Taylor-White tests published during the Paris Exhibition, and the Manchester trials of 1903, Mushet steel has been made the standard of comparison. As I pointed out at the Manchester discussion (see Transactions of the Manchester Association of Engineers, 1903, pp. 255, 338, 339, 340, 341, 345): "The treatment was as important as the position of the steel." Subsequent developments have proved the truth of my contention, although at the time my critics maintained the fallacy that the heat hardening treatment of Mushet steel was a new idea.

12 The points on which I wish to lay emphasis are:

a That high speed steels are the natural outcome of Mushet's discovery known as "Mushet Steel."

b That previous to the Taylor-White process, Samuel Osborn & Company, the makers of Mushet steel, had recommended a high heat hardening treatment; and

c That Messrs. Taylor and White further improved on this heat treatment and made it widely known, the result being an epidemic of high speed steels.

13 For these reasons my company calls their present product

Mushet High-Speed Steel, their contention being that it is *not* a new steel but the result of improvements on the original Mushet steel.

14 Referring to the system of lathe trials conducted by Mr. Taylor, it might be interesting to him to know that generally speaking the trials conducted at the works with which I am connected are on the same lines:

STANDARD SHAFTS FOR LATHE TRIALS

Taylor	*Osborn*
Steel (Carbon .35%)	Steel (Carbon .50%)
Steel (Carbon 1%)	Steel (Carbon 1%)
Hard Cast Iron	Hard Cast Iron

The feed and cut adapted havebeen the same, viz: $\frac{1}{16}$ inch by $\frac{3}{16}$ inch.

15 In conclusion, I should like to repeat a remark often made by my late father to Mr. Benjamin M. Jones of Boston, a personal friend and prominent man in the steel trade of the United States:

"Mr. Jones, it (referring to Mushet steel) is a sleeping giant, and will someday wake up."

Little did he realize how true his words were and what a vigorous share in the waking process would be taken by Messrs. Taylor and White.

MR. J. E. STEAD Ever since the introduction of high speed cutting steel by Mr. Taylor and the method of treatment introduced by Messrs. Taylor and White, I have devoted much attention to the study of what composition of steel is best to give the most efficient all around result. It is, however, inexpedient for me to say more than that some of the steels which gave the best results contained between

0.6 and 1.0 Carbon
2.5 and 3.5 Chromium
11.0 and 18.0 Tungsten.

Some steels contained high percentage of silicon, the amount varying between 1.5 and 2.5 per cent and they gave very satisfactory results in the engineering shops.

2 The practical trials were all made under the direction and superintendence of Mr. John Key, of Messrs. Richardsons, Westgarth & Co., Engineers, Middlesborough, who has devoted much time and attention to ascertain the performance of high speed steels when used under varying conditions. At my request Mr. Key kindly sent me the result of his experience, which is as follows:

The paper on "The Art of Cutting Metals," by Mr. F. W. Taylor, read before The American Society of Mechanical Engineers, is of a most comprehensive nature.

Those who have attempted experiments on tool steel and their classification can appreciate the labor and care required to produce the information in the form given.

Our experience with high speed tool steel and metal cutting confirms, so far as we have gone, many of Mr. Taylor's conclusions, notably the weakness of the feed mechanism of the ordinary lathe.

Some time ago a number of our old lathes were fitted with high speed heads with only slight modification to the feed gear, the result being, of course, disaster, and the design was altered as far as the arrangement of the lathe would permit but even now is not at all satisfactory.

When we commenced high speed cutting we considered it to be the proper thing to remove as heavy a weight of cuttings per minute as the tool and machine would permit, regardless of the power required. After a number of experiments it was found that beyond a certain weight of chips removed per minute, the consumption of current was excessive and did not compensate for the extra work done, therefore the cutting speed was reduced to that which was considered the economical limit.

A defect which has troubled us to a great extent in high speed work is that of the irregularity of the turned surface, necessitating several finishing cuts. The irregularity was caused through the vibration of the work and sometimes the result of the wearing of the centers with heavy pieces.

Although great progress has been made in roughing out wrought iron and steel bars and forgings, scarcely any improvement has been made in the time required for finishing in the lathe.

The author of the paper does not go into the matter of cutting metals on planing machines where the removal of the chips take place under different conditions from that of a cylindrical surface, as in a lathe.

In cutting cast iron in a planer we find a cutting speed of 50 feet per minute a fair average, similar material in a lathe being tooled without trouble at a speed of 120 feet per minute.

The planers are specially built for high speed work and have particulars as follows: 56″ x 12′ stroke cutting 50′ per minute and return 125′ per minute. 24″ x 6′ stroke cutting 50′ per minute and return 230′ per minute. The shock of return is taken by heavy spiral springs to which is attached the driving rack.

In conclusion I would like to express our indebtedness to Mr. Taylor in publishing freely the results of so many years investigation and which cannot fail to be of the utmost assistance to those of us who are interested in "The Art of Cutting Metals."

3 I most heartily endorse Mr. Key's praise of the most valuable of work Mr. Taylor. The engineering world in particular is greatly indebted to him.

Mr. Oberlin Smith I think we cannot fully appreciate, unless we have made comparative tests, the losses due to slow speeds in the old fashioned shops. As an instance; going through one of our largest shipbuilding concerns, I saw the rough job of drilling boiler heads for manhole contours going on at a rate of six feet cutting speed per minute all day long, simply because nobody paid any

attention to how fast the drill ought to run. We cannot attach too much importance to this new and grand era of reform, which means billions of dollars added to the wealth of the world, and which started with the incomparable work of Mr. Taylor and Mr. White.

2 In driving the new and extra powerful tools for using high-speed steels, much attention has been paid to trains of gearing and endless chains for getting sufficient torque, the poor old fashioned belt being neglected, as being too weak and of no account. The trouble with the old time belt drives has usually been because the belts have been run much too slow and hence not having the capacity to transmit much energy. We all know that we can run a belt up to a speed of about a mile a minute if we want to, although the best practice would probably be to keep down somewhere near 4000 feet. This, however, depends upon the weight of the belt, the size of the pulleys, and other conditions, the chief evil to avoid being that of centrifugal force carrying the belt somewhat away from the pulleys and lessening the contact pressure.

3 In equipping the new works of which the writer is the head, he had occasion to equip 100 or more machine tools of all kinds—and no two exactly alike—for individual electric drive, he having considered "group driving" one of the fossils of ancient history. In doing this he has used various methods, in some cases retaining the old cone pulleys self-contained upon the machine, and driving with constant speed motors. In many other cases, especially for lathes, he has depended entirely upon variable speed motors with field control and two wires. By changing somewhat the ratio of one pair of gears in the back gearing of a lathe and mounting upon the old spindle cone or cone sleeve a large gear with a new shaft in front containing a pinion to drive the same, he has found the cheapest and most practical method to be the driving of this small shaft direct from the motor, with a short belt, running upon as large pulleys as possible, to give it a high speed. This should be of the best possible quality of leather, quite thin, and made permanent with a cemented seam into an endless belt. It can afterward be tightened as it stretches by a slight adjustment of the motor upon its shelf—this shelf usually being a casting attached to the head of the lathe, several inches above the spindle. A little belt of this kind running at from 3000 to 4000 feet per minute will have an enormous amount of power, and can be kept so loose as not to be strained up to its usual working limit, thus being very durable. Furthermore, when running so loosely, the shafts are not pulled tightly toward each other (as in the old fashioned shop) with a consequent saving of loss of power and money by journal friction and wear.

4 Many modifications of the above arrangements can be made, suited to the particular machine which is being equipped. The principal idea to keep in mind, however, is that the belt must be strong, thin, and endless. There need not be any fear of its being too short by having the pulleys too near together, providing it runs at a very high speed.

Mr. W. H. Blauvelt Mr. Taylor states in his paper on "The Art of Cutting Metals," that he discovered during the past year that vanadium is a useful addition to high speed steels. (See p. 11, paragraph 50, and page 219, paragraphs 1088–1094). I think it will interest Mr. Taylor to know that Patent No. 779,171 was issued on January 3, 1905, to Mr. John A. Mathews for the use of vanadium in both molybdenum and tungsten steels of the high speed type. This patent was mentioned in the "Electro Chemical and Metallurgical Industry" in February, 1905, and also in the "Journal of the Society of Chemical Industry" of February 15, 1905. This patent was applied for some six months before its issue and the first experiments bearing on the subject were made in 1903.

2 I know that Mr. Taylor will be interested in the corroboration of his discovery by the results of earlier experience along the same line. This is manifestly one of the frequent cases of the discovery of the same idea by a number of independent workers along any line of investigation.

Mr. Daniel Adamson By the courtesy of the author in sending me advance proofsheets with a request for some remarks in discussion I have been able to briefly review this paper. I am very glad of this opportunity as I was Honorary Secretary of the Manchester Committee which carried on the experiments frequently referred to by Mr. Taylor.

2 Paragraph 77 of the paper should be corrected. The Report of the Manchester Committee's trials was published by the Manchester Association of Engineers in their Transactions in 1903, whereas the paper referred to by Mr. Taylor and published in the Transactions of the American Society of Mechanical Engineers in 1904, Volume 25, was a later and individual effort on the part of Dr. Nicolson for which he alone was responsible.

3 Mr. Taylor in his paragraphs 79 to 82 criticises the method of procedure of the Manchester Committee in the light of his greater experience. I submit, however, that the Manchester Committee should not be judged in this manner, but rather from the point of view

of the general knowledge on the subject at the commencement of their experiments. The Manchester Committee had no previous experiments to guide them except the German results referred to by Mr. Taylor in paragraph 78 and which will be found carefully summarized in Appendix III of the Manchester Report.

4 The whole of the Manchester experiments were carried on by voluntary effort. The members of the Committee gave their services; the Municipal School of Technology provided the room, the power, and the clerical and technical assistance required for carrying out the trials and recording and elaborating the results; the eight firms concerned gave all the tools, and one of them gave also the material operated upon and loaned as large a lathe as the premises would admit; while the Manchester Association of Engineers bore the cost of publishing the Report and offering it to others outside their membership at a nominal price. The results were published immediately on completion for the benefit of the engineering world generally.

5 Mr. Taylor throughout his paper makes such generous reference to the Manchester trials, and the subsequent experiments by Dr. Nicolson on his own account, that I think he should in justice modify the deprecatory tone of his paragraphs 79 to 82.

6 Mr. Taylor criticises in paragraph 85 the suggestion from Manchester that the area of the cut can be considered as a single variable in its effect upon the cutting speed, and while I have no doubt that my friend Dr. Nicolson will take an opportunity of replying to the many criticisms upon our work in Mr. Taylor's paper that more directly concern his deductions, I must myself say something about this relation between the areas of the cut and the cutting speed attained as I find that during the discussion on the report at Manchester I made the following remarks:

> They had each had their own ideas as to the results to be shown by these experiments. I personally had been anxious to see some connection between the actual speed obtainable and the cross section of the cut being taken. This connection was shown by Plates 3 and 4. If they had a given class of work in their shops, and a given quality of iron castings or steel forgings, they could easily ascertain how much slower they would have to run if they increased the weight of their cuts, and quickly ascertain from the results now published the advantage of so doing if the work and the machine would stand the heavier cuts.

7 From Plates 3 and 4 in the Manchester Report referred to, it will be seen that on soft steel we obtained a speed of 54 feet per minute on a cut of .04 square inches area, a speed of about 78 feet per minute on a cut of .02 square inches area, a speed of about 112 feet per minute on a

cut of .01 square inches area and a speed of about 140 feet per minute on a cut of .005 square inches area. This curve was based upon cuts varying in ratio of depth to feed from 1 to 1 to 3 to 1, and it would be interesting if Mr. Taylor would tell us the amount of error entailed by our method when compared with his own, over the range mentioned in the Manchester Report. Judging from the author's Table No. 45, Folder 8, the divergence cannot have been great. See my diagram herewith which is self explanatory. It seems to me very unreasonable for Mr. Taylor to stretch an assumption, ostensibly based upon an extreme range of ratio of 3 to 1, by applying it to a case where the range is 16 to 1 as in his cuts of $\frac{1}{8}$ inch deep by $\frac{1}{8}$ inch feed compared with $\frac{1}{2}$ inch deep by $\frac{1}{32}$ inch feed in paragraph 85. No engineer reading our report for instruction, as distinguished from reading it for idle criticism, would be misled as suggested by Mr. Taylor.

8 There are a few differences in detail between Mr. Taylor's methods of carrying out these tests and those adopted by the Manchester Committee and I think it well to mention these, if only for the guidance of the future investigators Mr. Taylor refers to occasionally in his paper.

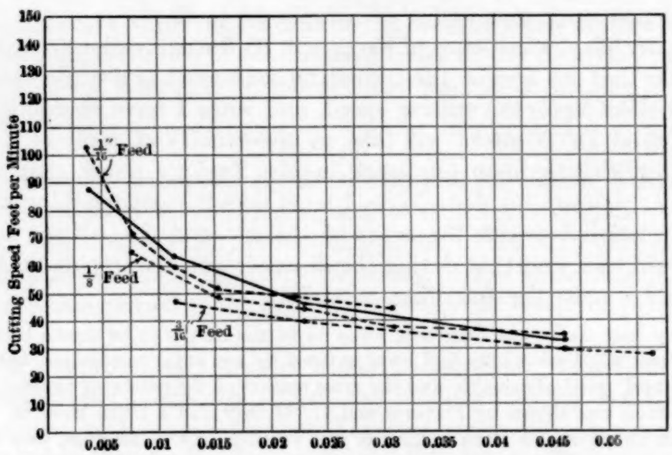

FIG. I DIAGRAM SHOWING COMPARATIVE RESULTS OF EXPERIMENTS BY THE MANCHESTER COMMITTEE AND BY F. W. TAYLOR

UNBROKEN LINE SHOWS RESULTS OF MANCHESTER COMMITTEE'S EXPERIMENTS ON STEEL CONTAINING 33 PER CENT OF CARBON. DOTTED LINES REPRESENT F. W. TAYLOR'S RESULTS ON STEEL CONTAINING 33 PER CENT OF CARBON.

9 We took the *mean of the diameters* before and after cutting when calculating our average cutting speeds. This is preferable to using a rotameter on the "larger of the two diameters of the forging" as

mentioned in paragraph 231. While I strongly recommend a "cut meter" for general shop use in checking speeds, the rotameter is absolutely unreliable for a "scientific" trial.

10 At Manchester we *weighed* the cuttings removed during each trial as a check upon the other measurements of cut, speed, time, etc. We kept a record of the longitudinal distance traveled by the tool during a trial merely as a check and we also noted the revolutions of the lathe spindle during each trial as shown by an automatic counter. This is much better than depending upon the rotameter as mentioned in paragraph 233.

11 The depth of cut applied at each trial was gaged by a graduated disc on the screw of the saddle, just in the manner in which cuts are applied in milling and gear-cutting machines, using the screw as a micrometer and adding an amount, previously ascertained as correct for the given cut, to compensate for the spring of the tool and rest.

12 This method is much more "scientific" than Mr. Taylor's, notwithstanding paragraph 241. In any case, I do *not* approve of the "cut gage" illustrated, as a handy tool to use on a forging in a lathe traveling at such a high speed that calipers cannot be used, see paragraph 238. We measured the bar at *several places* before and after the cut had been taken. We recorded the different diameters as mentioned in paragraph 241 just as we recorded many other points, for the same sheets are issued in financial affairs, that all concerned may see what has been done. It would have been interesting if Mr. Taylor had recorded *his* actual measurements in the same way. Mr. Taylor's paper, voluminous as it is, is singularly deficient, for an engineering paper especially, in giving such records as will enable a careful reader to check the deductions arrived at.

13 Throughout our records, particulars were given that would, we anticipated, enable future investigators to analyze our results and possibly draw fuller deductions from them than we did. There are many conclusions given in Mr. Taylor's paper as the result of his long continued experiments; but the grounds upon which they are based, or the method by which they may be applied in practice are omitted. For example, I may refer particularly to paragraphs 279 to 288 and to the "conclusions" given in Table 45 and other similar tables. "To err is human" therefore readers should be given every opportunity of ascertaining for themselves whether there is any error in drawing the conclusions.

14 I must enter an objection to the suggestion in paragraph 415 that the trials held in Manchester were in any way a "competition." The Manchester Committee looked upon their effort as a preliminary

attempt to show what was possible with the then new steels and a beginning in investigations that would go on indefinitely, and it was in no sense a "competition" between the different makers as Mr. Taylor suggests.

15 Paragraph 426 contains advice as to the importance of lowering tool supports that I gladly endorse as I have kept this point in view for about ten years past, when buying lathes, in order to be able to use the "turned up" tools, but I am much surprised to read his criticism of American Machine Tool Builders in paragraph 583. This is not the impression one would gather from reading the American technical press, although it confirms a very general English opinion that the gearing, especially of American lathes, is too light.

16 Referring to paragraphs 35, 45, and 120, Mr. Taylor cannot be expected to know the shop practice of England, but one of my fellow members of the Manchester Committee assures me that he has known of a heavy stream of water being used on tools for the past 30 years without discovering so great an advantage as 40 per cent, and he suggests that 1 per cent as mentioned in paragraph 629 would be nearer the mark according to his own experience.

17 Mushet tools were freely used *long before* 1894–1895 for turning and planing large surfaces of cast iron that required to be completed at one setting of the tool, and the employment of special men to grind all the tools in a shop has been very common practice for at least the past twenty-five years.

18 A strong stream of water was used in my own works 20 years ago to enable the carbon steel drills of that period to get through hard iron castings.

19 In paragraphs 247, 473 and 1016, Mr. Taylor gives some valuable recommendations as to tool grinding, and I would like to ask him whether there are, in his opinion, any substantial grounds for a very common preference in England for the use of sandstone rather than emery wheels for tool grinding.

20 In paragraph 496, Mr. Taylor states that the side pressure on a tool is often equal to the downward pressure and yet in his special pleading for the rectangular section of tool in paragraphs 415 to 421 (as being preferable to the square section used in the Manchester experiments) he forgets this. If the two pressures are equal, then the square tool is evidently more nearly correct, if the reasoning illustrated in Figs. 14, 15, 16 on Folder 2 is to be relied upon.

21 In paragraphs 784 to 794, several constants are given for use in various formulæ for calculating cutting speeds for various sizes of tools but these are apparently only for one quality of steel—medium—

nor do I find in the paper any guidance for ascertaining similar constants for hard and soft steels. Is this in accordance with paragraph 131 which states that one of the principal objects of the paper is to make public the results of the experiments as embodied in laws, etc. And further, the very formulæ given are much too elaborate for use outside a mathematical class room.

22 Mr. Taylor has chosen a too comprehensive title for his paper "The Art of Cutting Metals," as he has barely touched the fringe of that subject. There is little reference in his paper to drilling or planing and none to milling and gear-cutting, nor are any other metals than iron or steel referred to.

23 There are a few points not referred to by Mr. Taylor regarding which I hope he will give some information from the stores of his long experience when replying to the discussion.

24 What is Mr. Taylor's opinion of tool-holder tools for turning and planing? In England, the use of high-speed steels has given a great impetus to the development of tool-holders in which a small piece of tool steel is held to do the cutting, the stresses being taken by the body of the holder. The advantages claimed are that the outlay for expensive tool steel is reduced, while the grinding and tempering is simplified and no forging is required. This elimination of *forging* is alone a most important feature, as may be judged by the large amount of attention Mr. Taylor has devoted to it in his paper.

25 Again, there is no reference in this paper to the height of the cutting edge in relation to the "centers" of the lathe. Does Mr. Taylor intend the tool always to be placed "on the center or elsewhere? There is a strong opinion in England that the height of the tool in relation to the center of the work has a great influence uupo "chatter."

26 Also Mr. Taylor makes no mention of the difference experienced between cutting "acid" and "basic" steel forgings *of the same chemical analyses.* I have reasons for believing that this is an important point and should be regarded as another "variable."

27 Again in paragraph 372 Mr. Taylor speaks as though dead soft steel were something comparable with "wrought iron." This is not correct from a machinist's point of view. Wrought iron is much more troublesome to cut than steel.

28 Mr. Taylor makes no reference to the effect on cutting speed of the "skin" on the outside of forgings and castings that must be negotiated by the tool on the first cut, nor to the very hard spots that occur in machining large steel castings.

29 In conclusion, if my remarks seem rather disjointed, this must

be put down to the voluminous character of the paper, and also to the great amount of repetition. This repetition and some apparent contradictions make it appear as though the task of properly recording his work had been too great even for the tireless activity of the author and it does appear as if the paper would be enhanced in value by a careful editing and some reduction of its bulk. As an example of what I here refer to, please turn to paragraphs 35, 593, 594, 598 and 624 and the heading preceding paragraph 610, all of which repeat almost *ad nauseam* the statement as to a 40 per cent gain in speed by using a heavy stream of water on the tool, only to have the same contradicted, or at least reduced to 15 per cent in paragraphs 628 and 629. Paragraphs 674 and 675 are apparently mere repetitions, the one of the other. Also the large type following paragraphs 680 and 709. Also paragraphs 546 and 565. Also paragraphs 555 and 580. And there are many other examples throughout the paper.

30 Compare also paragraph 505 and paragraph 519 as to relation between cutting speed and tensile strength, these seem to contradict each other. Paragraphs 44 and 729 are very confusing. Paragraphs 1194 mentioning the author's failure to carry out his intention of explaining the best method of procedure in incorporating the various laws upon the latest type of slide rule is very disappointing to read after paragraph 51 had enlarged upon the great value of this part of the work and there does not seem to be any advantage in publishing it (paragraph 1194).

31 As an example of what might be done to simplify the paper, I would suggest the omission of the repeated references to the superlative merits of a trial run of 20 minutes duration in paragraphs 64 to 71, 137 and 703 and only retain the plain straight-forward statement in paragraph 183.

Mr. W. S. Huson This address and the discussion are of great value to those of us interested in rapid production. It seems to me, however, that the paper does not touch sufficiently on what to many of us, interested in comparatively lighter manufactures, is a vital factor in production; that is, the accuracy of the work when machined. Take as an instance a printing press type bed, a rectangular hollow or ribbed casting three or four inches thick and say four by six feet area of surface. When planed this piece should be within a thousandandth of an inch, by test, by the straight edge. When planed at high speed the work heats and the dulled cutting edge tends to lift the stock and plane out hollow portions in the surface. While the piece undoubtedly leaves the planer quicker than with slower speed and

carbon tool, when the manual labor and the time taken to file or otherwise dress the surface to the required accuracy, are added to the cost, nothing is gained and the hand labor is lost for some other work where it could be used to better advantage.

2 The same feature applies to milling; the high speed cutters seem to peen the work so that within a short time after being removed from the miller, it has changed from its orginial condition to the extent that slower speeds and the sharper carbon cutters give better results at a less final cost.

3 It is often the case that a manager will dwell on the speed with which he can do certain operations and overlook the charge for the cost of afterwork which could be avoided by slower speed at the start. High speed steel has been a revelation as to what can be done in rough reduction of stock, but I do not consider carbon steel a back number. It has its field and undoubtedly the advent of high speed steel has brought out qualities in the carbon to which little or no attention had previously been given.

4 To Mr. Hawkins' remarks on the all around man, he is going out of use because he does not fit in the modern shop. The same applies to the so-called all around tools of the past. To day, it is a gear cutter for cutting teeth, a miller for milling, etc. The mission of the all around man is done. The anchor must be of known quantity to the skipper, the fiddle true to the master's touch, and each should be made by him skilled in its making.

OUR PRESENT WEIGHTS AND MEASURES AND THE METRIC SYSTEM

By Henry R. Towne, Published in November Proceedings

Mr. George Schuhmann I do not intend to go into any discussion of the scientific merits of the metric system, but having lived in Germany before, during, and after the time the metric system was put in force there, having worked in a shop where both English and metric measurements were used side by side, and in addition thereto having used the English system in almost daily practice for over thirty years, I want to confine myself to the practical side of the question only, and at the same time give expression to my opinion, based on these many years of actual experience, that for the average daily practice the metric system is much easier on a man's mind, and a still greater mental labor saver to those who have to calculate much in volumes and weights, moments of inertia, etc. I also wish to

state that the fears of most of the anti-metric advocates of the terrible confusion and enormous loss of money that would result if the metric system was introduced here, are very much exaggerated.

2 All admit that it would be a desirable condition if the weights and measures of all civilized nations were alike, and no reasonable mind could expect the metric countries to give up their rational system for the English system, no more than one could expect this country to give up its decimal system of dollars and cents and return to the guineas, pounds, crowns, shillings, pence, and farthings of England.

3 Much ado has been made by the antis that in metric countries some of the old measures are still in use. But what of it, if they are? Do not condemn the rule on account of a few exceptions. Let the jeweler sell his diamonds by the carat and let the textile worker spin his yarns by the yard, but do not let that hinder us from abolishing the various sizes of barrels, gallons, bushels, pecks, cords, perches, hundred-weights, long, and short tons; the rods, chains, feet and decimal fractions of feet by civil engineers; the feet, inches, and vulgar fractions of inches by mechanical engineers, etc., etc., while the chemists, electricians and scientific men are already contentedly using the metric system.

4 I have no doubt that some of the old terms would also survive for many years in this country. The farmer would very likely continue to sell his peaches by the "basket," his strawberries by the "box," and measure the height of his horses by "hands." But this will not confuse the metric system any more than the English system, since it has no direct relation with either of them.

5 The firm I am connected with manufactured and shipped last year about 15,000 miles of tubular goods in the shape of wrought iron pipe, boiler tubes, etc., and every length of this had to be measured in feet and inches and then added by the tally clerks. On most goods we ignore fractions of inches, or else the job of adding would be still more complicated. If this same work were done by the metric system, giving the lengths in centimeters, it would be much nearer to the actual length and require considerable less mental work.

6 While some new gages would be required, most of the existing ones for inter-changeable work could be retained and simply be rechristened into metric terms if so desired. Much stress has been laid upon the fact that all the English dimensions cannot be expressed in metric units without going into many decimals, but for all practical purposes a few decimals will answer, and in most cases can be omitted altogether. The circumference of a circle in proportion to its diame-

ter cannot be expressed exactly in figures, and still for all practical purposes 3.14 is good enough.

7 Many U. S. standards are only nominal sizes anyway. A 3-inch turned shaft is generally $2\frac{15}{16}$ inches in diameter. A 2-inch dressed plank is supposed to be made of lumber which was 2 inches thick before it was dressed, leaving it about $1\frac{3}{4}$ inches thick when finished.

8 The wrought iron and steel pipe sizes are only nominal. They are supposed to express the inside diameter of the pipes, but that is only up to 12 inches. Above that it means the outside diameter; and all boiler tubes are also measured by the outside diameter. A $\frac{1}{2}$-inch pipe has a hole of practically $\frac{5}{8}$-inch, while a 1-inch double extra heavy pipe is less than $\frac{5}{8}$-inches inside diameter, but it is explained that the outside diameter of the 1-inch double extra heavy pipe is the same as the so-called 1-inch standard pipe, which is supposed to have a 1-inch hole, but which actually is about $1\frac{1}{16}$ inches.

9 When the question of uniform pipe threads was up before this Society twenty years ago, all the pipe manufacturers of this country claimed that they had made their gages exactly to the figures given by the Briggs formula and still their goods did not inter-change with each other. At the suggestion of this Society's committee each manufacturer sent samples of pipe, threaded according to their gages to the Pratt & Whitney Company of Hartford, Conn., so as to have them compared with the gages which the Pratt & Whitney Company had made with great care to comply exactly with the Briggs standard. Some of the samples varied as much as six or seven threads; *i. e.*, the pipe of the one manufacturer would screw from six to seven threads farther into the Pratt & Whitney Company gage than that of another manufacturer. (See Vol. 8, page 32, Trans. A. S. M. E.) The consequence was that nearly all the pipe manufacturers of this country purchased new gages from the Pratt & Whitney Company, which were exact duplicates of each other and the interchangeability of all pipes of different manufacturers was very much improved.

10 All these gages can be, or, in fact, should be, retained, because from a practical point of view the American standard for pipe threads is superior to the English or other European pipe threads, on account of the greater taper. All that would be necessary would be to call the old gages by the approximate metric dimensions. Of course, it would also be desirable that the English pipe threads, as well as bolt and nut threads, should be interchangeable with the United States standards, but that they are not interchangeable now, is not the fault of the metric system.

11 With the pipe threads remaining, according to the old stand-

ards, it would not be necessary to tear the old gas pipes out of the houses or ceilings to fit a new chandelier, as had been hinted in some of the previous discussions.

12 It would also be unnecessary to relay our railway tracks and rebuild the rolling equipment. All we have to do is to call the track 1436 gage instead of 4 feet 8½ inches. Air brakes, hose couplings, car couplers, etc., could all remain exactly as they are now.

13 Mr. Towne fears that 95 per cent of the present army of government clerks would be disqualified for a long time from doing efficient work if the metric system was introduced here, but I believe that he is doing the government clerks an injustice. I have seen the metric system introduced in an American machine shop so as to produce work according to metric dimensions. The workmen were all Americans who had not used the metric system before, and in a few days they had thoroughly mastered it—at least as far as their work was concerned—and I should think that the government clerks would be able to do as well as machinists.

14 I am well aware that a change of this kind cannot be made suddenly. In Germany the schools had prepared the younger generation for it some years in advance, and when the change finally did come it caused comparatively little confusion. The old carpenters and other old mechanics who had used the foot rule all their lives naturally were somewhat slow to use the new system, while most of the machinists, on account of their using smaller fractions, took to the metric system very quickly.

15 The younger people had patience and tolerance for the old people's habit of calling things by their old names, and as they understood what was meant, no confusion was caused thereby. It was very similar to the practice which I remember to have been in vogue in New York and Long Island about thirty years ago when the old inhabitants would use the word "shilling" in speaking of values, not the English shilling of 24 cents, but a shilling of 12½ cents. They would even prefer to say eight shillings rather than one dollar. I do not suppose that any merchant made his calculations or kept his books on the shilling basis, prefering no doubt the decimal system of dollars and cents, but this did not prevent him from doing business with the old folks, if for the sake of sentiment or from force of habit they would call for twelve shillings' worth of goods, nor did it cause him any serious mental calculation.

16 I well remember when working in a machine shop in Germany, we used the Whitworth taps and dies for bolt and screw threads and called them by their English dimensions without in any way interfer-

ing with the use of the metric system for the other work. I understand that these screw threads are still made according to the same Whitworth standards but are now called by their nearest dimension in millimeters instead of fractions of inches; this points the way how easy it will be to maintain existing standard gages, including Mr. Towne's lock part of 0.51 inches without interfering with the use of the metric system for general purposes.

17 On the other hand, consider the advantages of the metric system to the vast army of draftsmen. There does not appear to be any fixed rule with the English system in regard to figuring drawings. Some mark 1′10″ while others will mark it 22″, and I know of expensive errors made on account of reading 22″ instead of 2′2″, and other similar misreadings. Such errors are practically impossible with the metric system, as the misplacement of a decimal point makes the error so obvious that it is easily discovered.

18 Metric drawings are generally made to one of the following scales:

Full size, half size, 1 to 5, 1 to 10, 1 to 20, 1 to 50 or 1 to 100; all of which can easily be measured with an ordinary metric rule. Compare the attempt of measuring with a common English rule some distance on a drawing $\frac{3}{32}$″ to the foot with the ease of doing the same thing with a metric rule on a drawing 1 : 100.

19 I am very much surprised to learn that so many influential members of this Society have such a great fear of, and are so strongly opposed to, the introduction of the metric system. I can only assume that they are unfamiliar with the practical use of it, for I am sure that if they would cultivate a closer acquaintance with the beauties of the metric system in actual use their opposition would soon fade away. The metric system is bound to eventually supersede all other systems of weights and measures. I do not mean to say that this will happen in the near future, as it appears that the majority is not ripe for such a step just yet, but another generation will take it up—one that will consider this matter with less prejudice and less fear—a generation of engineers who will not hesitate to temporarily inconvenience themselves, and even go to a little expense in order to make the work of draftsmen and mechanics and, in fact, of all people who have to calculate in weights and measures, less laborious.

20 The rapid growth of electrical equipment is making it more and more necessary for the mechanical engineer to familiarize himself with electrical science, just as a knowledge of chemistry is indispensable to the metallurgical engineer, or that of geology to the mining engineer and civil engineer. Since all electrical units are

based on the metric system, and since the chemists and scientists all over the world are using it now, I know of no better medium than the metric system to facilitate the acquisition of that knowledge which is necessary to the engineer to enable him most effectively to adapt the achievements of science to the use of mankind.

MR. SAMUEL WEBBER I cannot too strongly emphasize the great pleasure and satisfaction with which I have read Mr. Towne's admirable and exhaustive paper on Weights and Measures. I have spent the greater part of a long lifetime in the use, examination, and determination of these subjects and Mr. Towne has given his views on them so clearly that it leaves but very little comment to be added. I can only hope that such a commission as he suggests may be guided by a continuance of the old Anglo-American standards of the foot and pound.

2 The "foot pound" as established by James Watt is the basis of a large part of our dynamics, and any change to such an uncouth expression as a "kilogram meter" would be a great blunder.

3 With regard to measures, the whole continent of North America is laid out by them from the feet and inches of house lots in New York and San Francisco to the acres or miles of every western ranch or railway.

4 Some minor changes in measures of capacity might be advisable. The American gallon could be conformed with that of Great Britain and made ten pounds; the pint, according to old usage, one pound, and two pints a quart. Instead of a quart the gallon could become a component part of a bushel, although the value of the latter measure, in all grain and vegetables, is now usually expressed by its weight in pounds.

5 There is, however, another subject which I think might well be considered by the same or a similar commission and that is our coinage. Our unit of value is expressed by the old Spanish "milled dollar" and is said to contain a certain number of grains of gold. Now if this number of grains of gold were reduced about 3 per cent, our half eagle or five dollar gold piece would be of equal value of exchange with the British sovereign or pound sterling. The silver dollar would correspond to the French five franc piece, while the quarter dollar would agree with the English shilling and the German mark. This would simplify the rates of exchange materially, and while it would necessitate a fresh coinage of our gold currency, our present silver coins are of such inflated value that they might be retained in use without difficulty or detriment.

6 Though this matter is not strictly pertinent to the subject, I beg leave to offer the suggestion for consideration should any such commission be appointed.

7 I do not feel sure after reading the discussion offered by other members of the Society that such a commission is desirable, but offer these suggestions in favor of a more perfect agreement on these points among the English speaking people, who in population and power are taking the lead among other races of the world. The statistics submitted by Mr. Halsey, show the general popular disregard of the laws making the metric system compulsory, and it seems to me, that adherence to the old Anglo-American standards, somewhat modified, as suggested, is in the course of events bound to supersede the somewhat imaginative French system, forced into use by Napoleon, under entirely different circumstances, and which after all, is based on a decimal division of the old duodecimal system of astronomical and geographical measures.

Mr. L. D. Burlingame No matter how much opposed we may be to the Brown & Sharpe Manufacturing Company in the adoption of the metric system, and how much inclined we might feel to believe that its compulsory use would be disadvantageous to our country, we recognize that a discussion like this should be judicial in its character rather than partisan, and that it should be open to full debate and that we should attempt to get at the truth. That is, we would not object to the appointment of a commission that was entirely competent and unpartisan, although it has been suggested here that such a commission could not be brought together. If it could, we see no objection to its being appointed by the President, for an investigation.

2 We feel that the Bureau of Weights and Measures has been the proper place for such work to be done. We have urged that they take up the matter of simplifying our weights and measures, and especially to try to bring about uniformity between America and Great Britain, and this is one of the things that a commission, such as is advocated, might take up. We have failed to make any impression so far on the Bureau of Weights and Measures. They have taken a partisan position and we do not feel that we are getting the help from that direction. It would seem as if from some source of authority there should be steps taken that might bring improvement in these minor details, and in points now open to criticism in our present system, I see no reason why the American Society of Mechanical Engineers should be seriously opposed to any fair minded discussion or presentation of the case.

Mr. Jesse M. Smith I worked for over three years with the metric system, and I found it most simple and convenient. It has been said that quite a number of countries, including France, which are supposed to be using the metric system, do not use it. I have been abroad a good deal, and I have been in several different countries where the metric system is supposed to be used and is used. Summer before last I was in Austria where it is supposed they do not use the metric system, but I found all the mountain roads and the country roads that I traveled over were measured in kilometers, and Austria is not supposed to be very progressive in that line. I took occasion to ask a number of Austrians whether there was any difficulty in passing from their old system of measurement to the metric system, which they have had for the last fifteen years. They said that they had trouble during the first two or three years, but none after that, and now the old system is practically forgotten. This reminds me of my own experience in Paris about thirty years ago, where the fruit women pushing carts in the streets would sell you grapes or cherries by the *livre* or half-kilo, and take pay in *sous* or centimes as you wished.

2 The significant fact remains, that notwithstanding the vigorous propaganda by some persons against the metric system in this country, that system marches steadily onward.

Mr. Samuel S. Dale The decision as to the creation of a commission must depend on what questions are to be referred to it, and who are to compose the commission. On some issues there can be no compromise, and of such is the compulsory introduction of the metric system into the United States, which Mr. Towne proposes to submit to a technical commission. This is what makes it impossible for an opponent of the metric system consistently to favor that commission as a practical proposition. To do so would be to admit that we are wrong. Now nothing seems clearer to us than that we are right, and for that reason we are unwilling to submit the vital issue in this metric question to the decision of any commission except one composed of 90,000,000 Americans. The metric fallacy having been established, the question now is not whether compulsory metric laws should be placed on the statute book, but rather how such laws can be kept off the statute book. That is the logical and sufficient reason for our opposition.

2 But if, in order to consider in detail the points raised by Mr. Towne, we should for a while assume that the question is still an open one, then we have only to turn to his fair minded and able argument to

find a statement of most convincing reasons why the commission should not be created.

3 In this discussion we can ignore the particular metric proposition that has been pending for four years in Congress, first as the "Shafroth" and then as the "Littauer Bill," each providing for the compulsory use of the metric system for government work. That scheme is now a dead one, but if it were not dead any one of the fourteen objections summarized by Mr. Towne in paragraph 73 would be sufficient to kill it. No commission is needed to bury it.

4 Turning to the other points raised by Mr. Towne, let us first consider the personnel of the proposed commission, the character of which is thus described:

> A commission is needed which should be composed of men of training, experience, and recognized authority in all of the many lines of industry, commerce, and science which are involved.
>
> Its members should approach their work with open minds, unprejudiced and untrammeled, solicitous only of learning the facts, of weighing all arguments, of hearing all interests, and of reaching conclusions which shall be sane, just, sound and permanently right.
>
> A commission is hereby created, to be called the commission on weights and measures, which shall be composed, in the discretion of the President, of not less than nine nor more than fifteen commissioners, to be appointed by the President, by and with the advice and consent of the Senate, and to be selected from various professions and pursuits and in such manner that, as far as practicable, every important interest, particularly scientific, industrial, agricultural, commercial, mechanical and maritime interests shall be represented thereon.

5 The truth of some propositions is so evident that it only obscures it to attempt a demonstration. Of such are the following:

a That no fifteen men ever lived who fulfilled the requirements of the Lilley bill;

b That if they were found the market value of each would be nearer a million than three thousand dollars a year.

6 Now for the sake of further consideration of this commission plan, let us assume the impossible, that a commission meeting the ideal requirements has been organized. What, according to Mr. Towne's own statement of the case, are the conditions that confront it?

> No country in the world, except the United States and the British Empire, now has complete uniformity in its weights and measures.
>
> Measured either by industry or by commerce, the English units of measurement are in use today at least as extensively, and probably much more so, than those of the metric system. Measured by colonizing and assimilating power, the Anglo-Saxon race, which uses the pound, gallon, and foot as its standards of measurement, far outranks all the countries which use as their standards the kilogram, liter, and meter combined.

To change the unit of length would be to substitute variety and confusion where now we have absolute uniformity throughout the Anglo-Saxon world.

As stated by John Quincy Adams, in his ever-memorable report of 1821, on the question of adhering to our present system or adopting the metric system, "The first position which occurs as unquestionable is, that change, being itself diversity and, therefore, the opposite of uniformity, cannot be a means of obtaining it, unless some great and transcendent superiority should demonstrably belong to the new system to be adopted, over the old one to be relinquished."

Certainly this comparison (of the English and metric systems) fails to show any marked preponderance in favor of metric units; if anything, it would rather prove the reverse.

Measures of length are linked irrevocably to the past. They exist, they are imperishable, and many of them never will nor can be changed so long as the things to which they apply shall endure.

7 With these statements we are in complete accord and, consequently, are not willing to consider the abandonment of our present priceless uniformity and to plunge into endless confusion by attempting the impossible task of displacing an established system of weights and measures by a poorer one.

8 Mr. Towne's reference to the example set by France and Germany seems to me particularly unfortunate for his argument. Both countries had confusion of weights and measures, which forced them to seek unification. We have uniformity and there is every reason why we should protect it. Their object was to find what we possess. It is ours to defend the possession of what they never have found. We read the official French confession of metric failure in the letter of M. Gaston Doumergue, French Minister of Commerce, Industry and Labor, dated April 11, 1906. These are the reasons why we will not compromise with confusion by referring to a commission the question of compulsory metric legislation in the United States.

9 Now having stated what should not be done, let me outline briefly what we think should be done. The greatest danger to our established standards lies in popular ignorance. This ignorance is largely due to the fact that scientific men, being practically the only people using the metric system, have favored its use not only for themselves, but for every one else. It has become the fad of schools and colleges. For years (thirty-five to my knowledge) the minds of children have been trained to believe in it as the only scientific system certain to become universal. Children leave school imbued with the metric fallacy. Why? "Because my teacher says so." Editors of newspapers, knowing practically nothing about the subject, have aped the schools and colleges, taught the fallacy and increased the ignorance.

10 In the encouragement of the popular ignorance lies the chief

danger to our established standards. The remedy? Free discussion, and if any legislation is required let Congress, pass a law providing that John Quincy Adams' report of his investigations, begun in 1817 with an inclination in favor of the metric system, and finished in 1821, shall be printed at public expense; that a copy be placed in every public library in the United States; that it shall be kept constantly in stock for free distribution to the public; that every President, Senator, and Congressman, shall receive a copy with a recommendation that it be read before passing upon any measure affecting the weights and measures of the United States. That alone would make compulsory metric legislation forever impossible.

11 The next danger to our established standards is the persistent efforts by bureau officers at Washington to discredit the English system and extend the use of the metric. Their acts in this direction are notorious. The National Bureau of Standards from its foundation a few years ago has been made the center of a metric propaganda. It distributes metric charts and metric literature at public expense. Throughout its bulletins there is a constant endeavor to throw discredit on the English system and create the impression that the metric is the only one worth having. From the foundation of our government it has been the settled policy of Great Britain and the United States to maintain uniformity of weights and measures by an exchange of material standards. In recent years, however, the promoters of the metric system in the National Bureau of Standards at Washington have, by a subterfuge, professed that "our fundamental standards are metric." Standards presented to the United States by Great Britain more than half a century ago and which formerly were guarded with the greatest care, have in recent years been discarded as worthless, treated as so much old junk, and exhibited as curios at national expositions. At the same time some metric standards made only sixteen years ago at Paris have been kept in a vault at Washington under a time lock, guarded as the only fundamental standards of the United States.

12 Nor has the pro-metric agitation of this Bureau been confined to the United States. It is but a few weeks ago that a Canadian manufacturer complained to me that the Bureau of Standards in the Department of Commerce and Labor at Washington was distributing metric charts and pamphlets in Canada. The manufacturers of Canada have their own official metric cabal to contend with. It is only recently that they obtained by a protest the withdrawal of a pro-metric lecturer who was stumping the country at public expense in favor of the metric system. Against the metric propaganda centered at Washington, however, the Canadians are powerless to contend.

13 A still more startling illustration of this pernicious activity came to light last year. A report on American weights and measures prepared by the American representative for the Exposition at Tourcoing, France, stated that "the American pound and inch are larger than those of England." Upon inquiry it was disclosed that the National Bureau of Standards was the authority for this mis-statement, whose only result was to create in France the idea that the linear measures of English speaking countries are not uniform.

14 The supporters of the metric system in the employ of the government are numerous, vigilant, and always on the spot. Their influence is exerted in many devious ways to discredit our established standards. At this writing there is a well concealed plan on foot to secure an appropriation by the United States for the compilation of agricultural statistics based on the metric system. It is in the form of a treaty creating an International Agricultural Institute with headquarters at Rome for compiling agricultural statistics. The supporters of the metric system in Europe have boasted that all the statistics are to be metric, which will make them practically useless to Americans, who are asked to pay for them.

15 It is against this continual pro-metric plotting in the government bureaus at Washington that the efforts of those who believe in defending our established weights and measures should be directed. Recent events have greatly improved the situation there. The Coinage Committee of the present House, which was in favor of the metric system when organized, is now on record against it. Practically all the members of the House, who in the 58th and 59th Congresses have supported the metric proposition, giving aid and comfort to the pro-metric lobby, will be missing from the 60th. It is as certain as anything in Congress can be, that compulsory metric legislation is impossible in the United States. The people who do most of the measuring and weighing in the country do not want it and will not have it. This fact should be made so clear that no one can mistake it. A consideration of Mr. Towne's plan can only obscure it. To his question, "We now have uniformity. Should we not hold it as a priceless treasure?" let the reply be an unmistakable "Yes."

A PLAN TO PROVIDE A SUPPLY OF SKILLED WORKMEN

By M. W. Alexander, Published in November Supplement

Mr. Fred W. Taylor No country can hope to hold its own in the severe industrial competition which is to come unless the rank and

file of its artisans and mechanics are educated as well as quick witted. I do not, of course, refer to a classical, or even scientific education. I mean a thorough grounding in the principles and rudiments of the trades at which they are working. In giving this type of education to their workers I believe that the Germans are in a fair way to outstrip us, unless we become fully alive to the necessity for this work and active in its accomplishment.

2 There are many different forces and potential elements in this country which might and should be directed toward the attainment of this object.

3 I am looking forward to the time when our trades unions shall be a much more useful element both to themselves and to the whole community than they have been in the past. When they shall be imbued with the spirit of helping their members as well as their employers through the arts of peace rather than the arts of war. When their chief thought may be that of educating and improving their members, and thus rendering them worthy of higher wages, rather than that of devising ways for forcing their employers to make concessions to them. I think the time will come when they will realize that the true and permanent road toward high wages and prosperity lies in so educating themselves as to be able and willing to do more work in return for larger pay, rather than in fighting to do less work for the same pay or the same work for larger pay.

4 However, I feel that we employers as a class need quite as much enlightenment in this respect as to do the working classes, and that we should be brought to realize thoroughly that not only our personal interest, but our duty lies in helping to educate our employees so as to be fit for a higher wage, and then in establishing such conditions as will enable them to get it.

5 The broad minded policy adopted by several of our larger companies, notable among which are the Baldwin Locomotive Works and the General Electric Company, in establishing systems for educating their apprentices, such as described in this paper, is to be highly commended. And I trust that all of our larger companies may in the near future follow their examples.

6 There are some advantages in the plan described by Mr. Alexander, of having apprentices taught in a department by themselves. But this plan is to my mind accompanied by the serious disadvantage that they are not surrounded by mature workmen. They are in competition with boys instead of men, and for this reason lack the most important object lesson of seeing skillful men working earnestly not only to do good work but to do it fast.

7 For our smaller engineering and manufacturing companies, however, in which ninety-nine hundredths of the work of the community is done, an apprentice system such as described is manifestly not possible.

8 As supplementary to the system described in Mr. Alexander's paper, I wish to call attention to a method by which not only apprentices but also those intelligent workmen who have not been so fortunate when young as to have the opportunity of serving an apprenticeship can be taught a trade quite as effectively in our small shops as they are in larger establishments under Mr. Alexander's system.

9 In the paper on "Shop Management," read before this Society in 1903, forming part of Volume 24 of the Transactions, will be found a description of functional or divided foremanship, under which each workman has eight daily foremen over him instead of one.

10 Each of these foremen devotes his energies to one-eighth only of the work in which the ordinary foreman is supposed to be proficient, and as a consequence acquires a competence in his specialty far in excess of that possible to the old fashioned, all-around man. Under this system these functional foremen are called upon not only to teach but to stand over and train the men under them into a knowledge of how to do their work and also to manual dexterity. The rapidity with which the workmen and apprentices learn under this constant supervision and help is indeed remarkable. And as this system can be established in small shops as well as large, with great profit both to employers and employees, it offers a ready solution to the problem of educating our apprentices.

Mr. H. K. Hathaway The shortage of efficient workmen, as Mr. Alexander has pointed out, is a problem of such vital importance that unless more attention is given to its solution, the expansion and development that our industries have enjoyed must inevitably be greatly restricted.

2 Every employer knows from bitter experience how difficult it is during times of prosperity like the present to obtain mechanics who are proficient in one branch of the trade, let alone men skilled in all its branches. This scarcity is due to causes of such a complex nature that I will not undertake to enumerate them.

3 Mr. Alexander has pointed out one way to overcome this unfortunate condition, in his description of the training shop for apprentices maintained by the General Electric Company, and it is with great satisfaction that I note that the scale of wages paid is about 50 per cent higher than are ordinarily paid apprentices, and

this alone, if generally adopted, would do much to overcome the disinclination that most boys and young men have to serve an apprenticeship and I believe that still better results would be achieved if the wages paid started at about $8 per week and went up by easy stages to $12 per week for the final period. If this were done it would enable many young men between the ages of twenty and twenty-five years who are entirely dependent upon themselves for support, to enter the field of mechanics, and such young men would prove a far greater worth, both during their apprenticeship and afterward, than boys from sixteen to twenty years old. Furthermore, the shorter hours, clean hands, and eight dollars per week of the clerk would not appear to such marked advantage over an apprenticeship to the machinist trade.

4 The trade schools offer a partial solution to this problem, but there are so few of them and the number of students in each is so limited that very little practical benefit can be looked for from that quarter, unless we can have, through the generosity of our millionaires, many more of them, and I am inclined to feel that this is a much more practical and useful way to get rid of burdensome millions than building libraries.

5 The training shop of the General Electric Company bears a strong resemblance to the trade school and from the fact that it is in close touch with a great manufacturing works, has many advantages over the trade school, and is infinitely superior to the haphazard instruction that is characteristic of the average apprenticeship.

6 I cannot help thinking, however, that there is one serious fault in the system described by Mr. Alexander, and that is in the fact that one man and two assistants are expected to instruct and maintain discipline among 125 boys, to interview and select new recruits, to study carefully the mental and moral makeup of each boy, as well as his aptitude for his trade, and follow up the progress of many other boys who are completing their course in the factory departments. This, it is explained, is made possible by utilizing most of the apprentices themselves for assistant instructors, and is in itself a statement that there is a shortage of men in charge. I do not see how instruction thus handed from one boy to another can be as efficient as it would be coming first hand from a competent and experienced instructor, and it is obvious that the progress of each boy must be seriously impeded by this method.

7 Unfortunately, however, the training shop plan is entirely out of the question for the average small manufacturing plant, and their

solution must come from another source. Mr. Taylor's plan of functional foremanship, seems to offer the best solution to the problem of supplying the demand for efficient workmen, and I believe that if it were applied in the General Electric Company's training shop, the good work being done there could be greatly enhanced, the instruction made much more thorough and accomplished in a much shorter time.

8 I have had the good fortune to be occupied, during the past two years, in the application of this plan as a part of the Taylor System of Management, in a works employing all told about one hundred and fifty men, and as a result this plant is not troubled in the slightest degree by the dearth of skilled mechanics.

9 Under this system of functional management, where formerly the apprentice had to depend upon one "overworked foreman" for his instruction, there are now several foremen, the most important of whom, so far as the matter of instructing the workman is concerned, are the gang boss, the speed boss, the inspector, and the shop disciplinarian. These men continually come in direct contact with the workman and each has a special function or duty to perform.

10 It is the duty of the gang boss to see that all preparations for each job is made in advance and to instruct the workman as to the best method for setting up his machine and setting and clamping the work. The speed boss decides all questions and has charge of all matters relating to the cutting speed, feeds, depths of cut, the kind and shape of tool to be used and the method of setting the tool, the number of tools to be used simultaneously, all matters connected with the proper use of soda water, and instructs the workman in the manipulation of his machine. The inspector is solely concerned with the quality of the work and instructs the workman in the degree of accuracy and finish required, while the shop disciplinarian, as his title implies, maintains the discipline of the shop.

11 Under such a form of shop management it has been found possible to take an absolutely green man, who has never worked in a machine shop, and make an efficient operator of him on a drill press, or turret lathe, in from three to eight weeks. From the drill presses the best of these men are promoted to milling machines and planers, and from the turret lathes to engine lathes, becoming proficient in each class of work in a remarkably short space of time, owing to the systematic and thorough instruction they receive from the various functional foremen. That these men are doing efficient work is fully demonstrated by the fact that in this shop we are turning out 100 per cent more work than was done before this system was installed, when every machine hand employed was supposed to be an all-around man.

12 One good example is a young man who started in about two years ago with no previous experience, and is now competent to run any machine in the shop and is at present running a lathe on which only work of a character requiring skill and accuracy is done. I mention this specific case because the man who formerly ran this lathe was looked upon as the finest workman in the shop, and at the time was the highest paid machinist in the employ of the firm, being considered indispensable by the superintendent in charge, when the functional system was started. This man, who was in reality a scientific loafer, objected to being told how to run his machine and as a consequence was allowed to leave, to be replaced by the young man first mentioned who not only turns out as good work as his predecessor, but about three times as much.

13 Another similar case is that of a young man who is now running a milling machine on which the most difficult and accurate work is done. This young man when he first came was considered so stupid that we almost despaired of making anything of him.

14 From my experience thus far, I firmly believe that it is possible under the system of functional foremanship, to turn out in two years an all around mechanic who is in all respects a more efficient workman than is ordinarily turned out in four years under the old system and at practically all times during this period of training, to get practically the maximum efficiency from each man by reason of the constant and thorough nature of the instruction and help received at the hands of the various functional foremen, while the wages paid are so high as to attract mature men rather than immature and unsettled boys.

15 It has always seemed to me the height of unfairness to withhold the privilege of bettering their condition by learning a trade from deserving men, who through unfortunate circumstances over which they had no control, were unable to acquire one, and to restrict this privilege to boys alone, who seldom fully appreciate it.

16 This state of affairs is probably due to the fact that under the usual system of management, an apprentice is considered an expense item for a large portion of his time and is consequently paid low wages and expected to accept the experience and instruction he receives, in greater part as compensation for the period when his services are profitable to his employers.

17 Under the system I advocate, I think there would be very little to fear from this shortage of skilled labor which is at present such a burning question.

PROFESSOR LANZA The importance of providing skilled workmen, and the active interest that the manufacturer should take in the subject is so evident, that it needs no further argument. In order that such education may be properly provided, moreover, the manufacturers must realize that the matter cannot be left to the generosity of the multi-millionaires; their generosity alone will never accomplish it. The manufacturer has got to realize that it is necessary that he should bear his share of the expense and effort to accomplish it, even at the risk of losing the service of the men whom he has educated, by their going to other competing firms. Whether the program is to be carried out in the shop, or by means of schools not connected with the shop, there are certain things that will have to be attended to which are needed in consequence of the nature of the boy himself. The author of the paper speaks of the teacher looking after the development of the boys. I think in any large establishment that a man will be needed to devote his entire time to looking after, not merely the schooling of the boys, but also their whole method of living. He should know where they board; how they live, and what are their habits. Then, there are other characteristics in the nature of the boy, which need to be carefully considered. A young boy is apt to look at any immediate raise in his pay as of undue importance; also he likes to aim high; he likes to imagine that he knows more than he does, and there is one great temptation in such schools, and that is to try to cover superficially a large amount of ground. Now, I think that the aim ought to be that everything should be done thoroughly, and what the boy has done shall be really accomplished.

MR. GEO. R. HENDERSON In connection with Mr. Porter's remarks, I would say, that about a year ago I noticed a large railroad shop, which was expected to employ about fifteen hundred or two thousand men, and at the very start the men had to walk for a mile or a mile and a half to the shop; the ground was torn up, there were no board walks down, and in rainy weather the consequences were that a great many men did not come to work because the facilities were too poor. I think that is one mistake we make; we ought always to look ahead to see that we will be able to get good men, and that they can be comfortably accommodated.

2 I would like to ask Mr. Alexander in regard to one of the points in his paper, and that is, how he manages to keep these men after he educates them so finely? I know of one young man who had been kept on a lathe 42 months out of 48, simply because he had

developed into such a good man that the foreman kept him there, and when I introduced a system by which the young men were changed periodically, the foremen were very much disgusted, to have some of these young men removed and sent to some other department. I would like to know how Mr. Alexander keeps his men after he educates them. It seems to me that some of our competitors would pay them larger wages after we have educated them. I would like to know also, how you take a "chunker" and make a full-fledged machinist out of him without antagonizing the labor unions.

Mr. L. D. Burlingame I can heartily endorse any plan that will help toward the adoption and development of the modern apprenticeship system. From my experience with such a system at the works of the Brown-Sharpe Manufacturing Company, I can see the importance of a system for training men to develop skill. It has been for many years our plan to give such training. I am glad to see that not only individual manufacturers throughout the country are taking up this matter of the apprenticeship system, but that organizations such as the Manufacturers' Association, that are interested in the development of mechanical industries, are also taking action in a way that will help to spread and develop such a system. Of course, I understand that such plans as outlined by Mr. Alexander, when applied to a shop, must be adapted to the conditions in that shop. At the Brown & Sharpe works we consider it is best to have the boys mix in with the other men from the beginning; whether it be pattern makers, machinists, or draftsmen apprentices, we have them acquire their knowledge by such contact throughout the time of their apprenticeship. One point in Mr. Alexander's paper that I have heard criticised is that one boy is allowed to teach another from step to step. I consider this an advantage, as it trains the boy who is acting as instructor as well as the boy being instructed, and if this is done under a competent supervisor, he will see that a high standard is maintained, in which case it does not lower the standard.

2 Regarding what President Taylor said as to making of specialists—we feel that we are carrying out this plan to some extent where a boy is given training in the important departments of the works, such as the planing, the milling, the lathe, and the assembling departments, for a certain defined period in each, and where there will be instruction under an expert in that line of work.

3 I shall watch with great interest the plan being carried out by the General Electric Company. I feel that Mr. Alexander, has out-

lined very clearly the needs of our modern manufacturers for skilled labor and the means for developing such skill, and it seems to me he has shown in many ways exceptional skill in the plans suggested. I cannot too strongly urge that the apprentice system in its modern form should be pushed and developed throughout our manufactories in this country.

Mr. C. F. MacGill. Mr. Alexander's paper is a very important one. No greater problem is presented to manufacturers and superintendents today than that of supplying the required number of skilled workmen. The plan under discussion furnishes, it seems to me, the best solution of the problem. I visited the apprentices' department of the Lynn works and found that the instruction given was very thorough and systematic, and of such a nature that in a remarkably short time the boys could be depended upon to do good commercial work.

2 In the primary training department work was done involving the simpler operations of drilling, boring, turning, balancing, etc., most of the work being on small cast iron pulleys. In the secondary or advanced training department, a really high grade of work was being done, turning armature shafts to a limit of one-half thousandth of an inch, making jigs and fixtures for use not only in the training departments, but throughout the works. I then went through some of the machine departments, where regular production work is done, and found the apprentices on that class of work for which it has been my aim for some years to train them.

3 I was particularly pleased with what I saw of their work in the steam turbine department at the River works. One apprentice in the fourth year of his course was running a ten foot vertical boring mill; others were working on large planers, milling machines, etc. It was very evident from the speeds and feeds used, that their training had been very thorough, and was producing good results. I cannot speak of the schools, as I was there in the summer, when they were not in session.

4 The impression seems to prevail among a number of engineers and educators that it is not necessary for an engineer or designer to be able to perform all of the operations involved in machine work, if he understands the underlying principles. I think this idea has done and will do a great deal of harm. The man who cannot do a given piece of work, does not really understand how to do it. Mr. Alexander has started right, and the system carried out at Lynn is producing good results. Combined effort along similar lines by manufacturers

and machinery builders in the United States will go a great way toward solving the question of providing the required number of skilled workmen.

Mr. P. W. Gates It may not be generally known to the members of the Society, that the Manufacturers' Associations are moving in this direction. For instance, the National Founders' Association have erected a building and established a foundry school at the Winona Technical Institute near Indianapolis and I know there is under discussion by the National Metal Trades' Association, the use of a large building at the same place which they intend to remodel for a school for the machine shop and kindred trades in which said association is interested, the work in both cases to be taken up along practical lines. That seems to me to be the logical solution of the problem. If such associations will take up the work there will be little difficulty in selecting the proper instructors out of the employees of some of its members and proper material to operate upon from their shops. I suggest this to Mr. Alexander, as anticipating his idea of trade schools.

2 I also want to say to Mr. Porter, regarding apprentices leaving shops as soon as they have finished their time that I have in mind an institution that turned out a good number of apprentices each year and which gave them their diploma and compelled them to leave. Their experience was that about seven out of ten would shortly return with sufficient additional wisdom to pay them compound interest on the investment.

3 I think Mr. Alexander's system can be carried further to good advantage; there should be two more grades of apprenticeship, one for the graduates of manual training schools with a shorter term and higher wages; another for graduates of technical schools with a still shorter term and higher wages. I have had a number of such graduates ask my advice about entering business and I have always told them that I thought their education at a dangerous point without being supplemented with shop practice to complete it and that then and not till then were they really entitled to have their diplomas signed and commence the post graduate course of their life work.

Prof. Edward Robinson It would seem that the plan of Mr. Alexander is one that could hardly meet all cases.

2 There are two parts to this plan that should be clearly distinguished. First, there is a general education; and second, a special training. In most modern apprenticeship systems, a fair general education is assumed before the young man enters upon his work.

He is then given his special training in the particular industry in which he has elected to serve. Mr. Alexander, evidently finding it difficult to get young men with the proper preliminary education, essays to make up the deficiency by giving the boys a more or less general education previous to, and along with, their special training. This is certainly a very good thing and under the circumstances seems to bring about the desired results in the easiest possible way. The question arises in my own mind if it would not tend to a more logical and permanent solution of the problem, if manufacturing concerns should aid in encouraging and founding separate schools, which would give the proper preliminary education leading to the apprenticeship work? Such schools should be thoroughly educational, should give training in mathematics, elementary physics, mechanical drawing, and manual training and have the avowed object of fitting the boy for apprenticeship work in the various neighboring industries.

3 The boy then should have some preferential treatment in the apprenticeship course, such as a shorter time to serve and more pay at the outset. Such schools would meet a decided lack in our present educational system, and if they could be established in various cities, it would not seem difficult, after they had proven their usefulness and efficiency, to have them become a part of the regular public school system. Such a school course followed by a good apprenticeship training, would give to a great many boys a far more effective and valuable education than any that is now open to them. For this reason it should command public confidence and support as soon as it has demonstrated its effectiveness and worth.

A MECHANICAL ENGINEERING INDEX

By W. W. Bird and A. L. Smith, Published in November Proceedings

Mr. Henry Hess No happier definition of "Index" than that given by Messrs. Bird and Smith as a "mechanical memory" can well be found. No doubt also that the index arrangement devised and adopted by them for the purposes of the Worcester Polytechnic Institute is a very good one. But is not the subject one that merits a much broader treatment?

2 Conceive that the various scientific institutions of the world agree on a definite uniform classification of all knowledge—that each indexes all matter in its libraries under the same heads that similar matter would be indexed by every other—that each member of such institution indexes his particular collection similarly. Conceive

further that all of these indexes be collected and copies distributed to all of the various institutions. The result would be an enormous simplification in making available to every worker in every field the recorded experience of every other laborer along allied lines. Instead of his being obliged, as now, to laboriously wade through the catalogue of this, that, and the other library—each one probably arranged along a plan sufficient unto itself—he would be under the need of consulting but a single index and with the certainty that, so far as human ability could compass it, he would there find recorded every source of information.

3 Undoubtedly the conception seems at first sight almost impossible of realization. The difficulties of the work itself are, however, not by any means insuperable; rather, it is the difficulty of getting the various scientific bodies to even agree to take up the plan. Possibly the best way to get the thing done is to make an actual beginning.

4 The various chief engineering associations of the country now united under the one roof of this most fitting habitation provided by a munificent generosity have already merged their individual libraries into one of far greater usefulness. In what more far reaching and widely beneficial way could they signalize and emphasize their realization of the importance of unity of endeavor, than by appointing a committee to plan and start a universal index such as that suggested?

5 An honored ex-president of this Society and leader in original work along sociological and engineering lines, Professor Sweet, once happily defined the usefulness of engineering calculations as providing "a basis of departure." It is with this in mind that I present the following outline for discussion.

6 The Dewey system of classification is probably familiar to most of the members. It contemplates the division of all knowledge into certain main heads, the further subdivision of each main head under subheads, and so on indefinitely. Its author makes each group consist of ten heads, one of these a collective one to take all matter not included elsewhere. To each head a number is assigned as, for instance, No. 6 Useful Arts, No. 5 (1st subhead) Engineering, No. 4 (2d subhead) Mechanical Engineering. These are not Dewey's numbers, but merely assigned for explanation. Any item pertaining to mechanical engineering would thus be found under 654. Steam Engineering would be a further subhead, say No. 7, and would be found under 6547, and so on indefinitely. The division into ten heads is, of course, an arbitrary one and desirable simply because ten is the basis of our system of numbering. To my mind this very arbitrariness of classification is a distinct advantage because from the very begin-

ning it does away with any attempt at a logical classification. Logic is a mental process and its application will always and necessarily be along the lines of each individual's mental processes. These latter are as diverse as are the lines of work followed, further differentiated by the personal equation. Even absolutely similar matter presents itself to different individuals from different viewpoints, so that each would group it otherwise with relation to cognate matters, and yet each grouping might be strictly logical.

7 As against the alphabetical arrangement, the Dewey plan possesses the advantage of being as international as is our Arabic number system. Assume for instance, that a German engineer wanted to inform himself on the subject of chain hoists, including also the American and English developments. His German index guide would inform him that 654–927–34 would cover everything on that subject in every language. Under an alphabetical arrangement he would first have to consult dictionaries to get the various foreign terms and only then—provided he were fortunate—he would be in the first stage of his still hunt. If, unfortunately, he might find that his dictionary translated "Flaschenzug" as "bottle" for "Flasche" and "pull" for "Zug," ergo "bottlepull." Not finding that in the indexes he would probably ask a friend for a synonym for "bottlepull" and get the obvious one of "corkscrew." The obliging library attendant passing out to him all matter referring to corkscrews would probably not deeply impress him with the value of an index scheme that resulted in such "carrying of coals to Newcastle," as giving a native of the Fatherland information about corkscrews.

8 One very decided advantage of the numerical classification lies in the readiness with which cuttings, extracts, etc., can be filed in numerical order. Data in book form would be stored on shelves, while catalogues, pamphlets, cuttings from papers, etc., would be filed in a limited variety of receptacles; letter symbols would be used to designate the character of the filing device.

9 All information on a given subject would thus be quickly found, distributed, at the worst, through only as many places as there were different classes of files, instead of having to be laboriously gathered together from many locations. It would be necessary merely to pick out all matter bearing the same numerical symbol. Its proper distribution after use would be equally simple and expeditious as would be also the proper interpolation of new matter from time to time. The gathering, distribution, and interpolation could be left to very subordinate help, whose chief qualification would be an ability to read numbers.

10 It would be of great advantage to have the various filing receptacles of standard size and design, possibly differing only in costliness to suit various purses; this would be in line with the already widely adopted size standards of catalogues, papers, etc., first advocated by this Society; it would also insure the uniformity of these place symbols, and so permit of the amalgamation of various collections of mere routine and almost mechanical distribution.

11 To burden a committee with the enormous task of grouping all knowledge under number symbols would result either in never even getting as far as its formation or its early resignation. But such burden would not be at all necessary. A start has already been made by the fairly wide adoption of a Dewey classification in many libraries. With this as a basis, the committee would confine its task initially to interesting as many members as possible in the task of revision and extension by each of a subgroup, to collecting the contributions, to forming subcommittees for the future consideration of this matter, and finally to a boiling down of the whole.

12 It may be fairly assumed that enough capable and public spirited men can be found to give their services without charge; still much clerical work and other expense would be involved. The needed funds could be secured by subscription of outright gifts and, as the work progressed, by partial advance payments for copies of the index, the final payments to be made on delivery. Members editing engineering papers and magazines should be moved to print the index symbol with every article, to refer their annual alphabetical index to these symbols and to add an index giving the different articles under each symbol. Some might possibly consider work of this character as beyond the scope of the Society, but certainly not if the purpose of its organization, broadly to further the interests of the engineering profession, be remembered.

13 If precedent is considered of value, that set by the Verein Deutscher Ingenieure—probably the largest engineering society in existence—in getting out an international technical dictionary, its "Technolexikon" will serve. It would be eminently desirable could the committee secure from the very outset the formation of and coöperation with similar committees from other engineering societies—those sharing in the administration of the Engineering Societies' Building would probably be easiest to interest—but, whether or no, the important thing is to make a determined start. The indubitable advantages of such an index issued by the Society for its field of Mechanical Engineering in detail must, with time—be it long or short—win wide and growing support.

14 Whether the Dewey classification suggested be adopted or not is immaterial, but let it be considered that of a vast body of engineers daily accumulating and more or less thoroughly indexing and classifying information, many would adopt the proposed universal index, that the most of these would be glad to respond to their society's request to bequeath their accumulations to it, that such matter would come under the control of the society libraries in an increasing flow and in a condition of almost complete readiness for absorption by mere distribution, then it must be clear that with time, the achievement of each individual worker will be made available to and benefit every other worker, and that with consequent decrease in duplication of effort, less energy will needlessly be expended and more be available for the furtherance of civilization.

THE FLOW OF FLUIDS IN A VENTURI TUBE

By Edgar Park Coleman, Published in November Proceedings

Mr. Charles E. Lucke From the experience with the Venturi meter for measuring steam and gas, I am convinced that the device has considerable value, considerably more value than is ordinarily credited to it. In some recent tests made on some large gas engines at the Lackawanna Steel Company's plant, in Buffalo, for the De La Vergne Machine Co., a large Venturi meter was used as one of four methods for measuring gas. This meter is shown in Fig. 1. The tube had an actual upstream diameter of $15\frac{7}{8}$ inches, and the measurements at this point are denoted by the subscripts (1); the throat diameter was $6\frac{1}{4}$ inches and this point is denoted by the subscript (2). The downstream diameter was the same as the upstream and readings are denoted by the subscript (3);

Let V_2 = velocity of gas at the throat in feet per second;
p_2 = absolute pressure of gas, lbs. per sq. ft. at throat;
v_2 = cu. ft. per lb. of gas at throat;
A_2 = area of pipe in sq. ft. at throat;
K = 1.4, a constant.

Then the formula of M. de St. Venant applies

$$V_2^2 = \frac{2\,g\left(\frac{K}{K-1}\right)p_1\,v_1\left[1-\left(\frac{p_2}{p_1}\right)^{\frac{K-1}{K}}\right]}{1-\left(\frac{A_2}{A_1}\right)^2\left(\frac{p_2}{p_1}\right)^{2/K}}$$

for this case

$$\left(\frac{A_2}{A_1}\right)^2 = \left(\frac{6\frac{1}{4}}{15\frac{7}{8}}\right)^4 = .024025$$

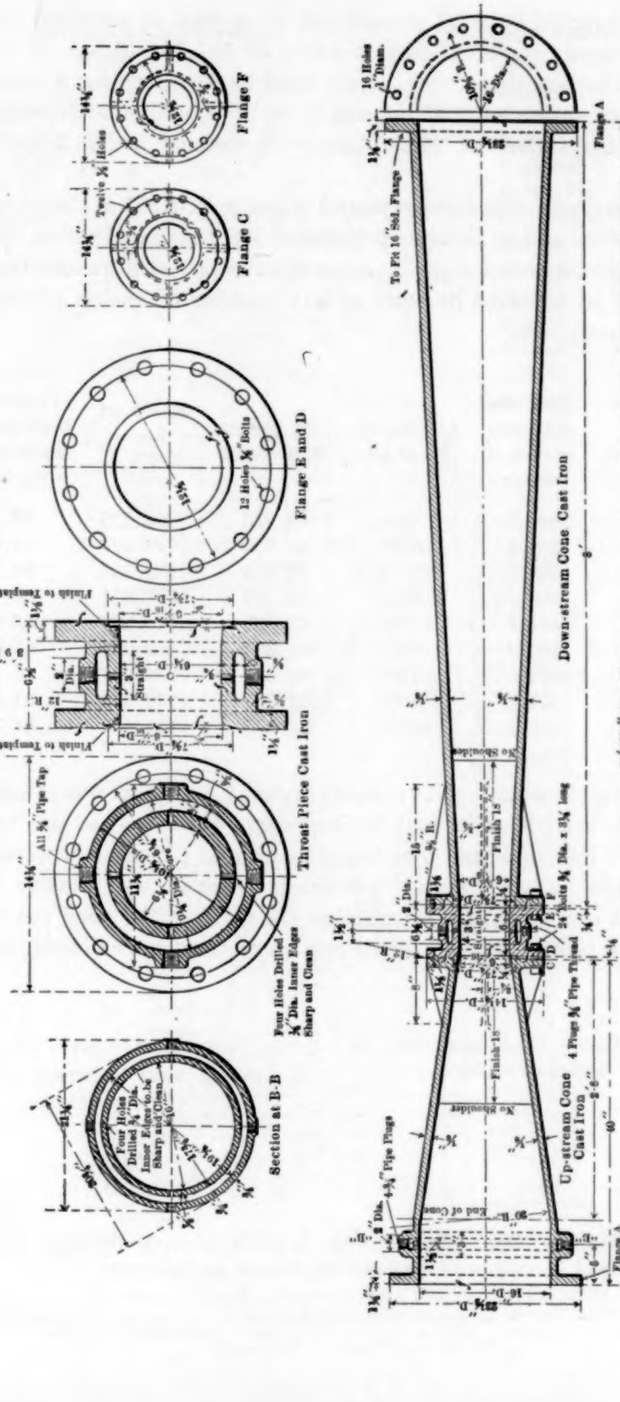

FIG. 1 A 16-INCH PORTABLE VENTURI METER FOR MEASURING GAS

This gas weighed 0.08227 pounds per cubic foot at standard atmospheric pressure of 33.947 feet of water, or 407.364 inches of water, or 29.922 inches of mercury. This must be corrected for a temperature of gas observed of 45 degrees F. and the barometer reported by the Weather Bureau of 29.249 inches of mercury or 398.2 inches of water.

2 This gives cubic feet per pound of gas = 0.07881 at the temperature observed and an absolute pressure of 398.2 inches of water. From this the velocity head of gas in inches of water or feet of gas can be computed for an absolute pressure of any number of inches above and below atmosphere.

Gas press. inches of water above atmos.	Absolute gas press inches of water	Lbs. per cu. ft. of gas	Lbs. per cu. ft. of water	Ratio wt. water / wt. gas	Feet of gas head per inch water velocity head
—1	397.2	.07861	62.335	793.220	66.102
0	398.2	.07881	62.335	791.207	65.934
1	399.2	.07901	62.335	789.204	65.768
2	400.2	.07921	62.335	787.211	65.601
3	401.2	.07941	62.335	785.229	65.436
4	402.2	.07961	62.335	783.256	65.272
5	403.2	.07981	62.335	781.293	65.108
6	404.2	.08001	62.335	779.340	64.945
7	405.2	.08021	62.335	777.400	64.783

3 Using these figures the velocity of gas at the throat was calculated for gas at these densities and for increase of velocity head due to the throat of 1 inch of water, 6 inches of water and 12 inches of water, by the formula. It was found that for increase in the velocity head increment due to throat contraction the flow varied very nearly as the square root of the increment and corrections were determined to be:

Throat velocity head increment in inches of water	Corrections to apply to $\sqrt{\text{velocity head increment}}$ method of computation
1	0.0000
6	0.0032
12	0.0051

Plotting these corrections on Fig. 2 gave the corrections for all velocity head increments due to the throat as follows:

Throat velocity head increment inches of water	Correction on square root method
1	0.000000
2	0.000304
3	0.000676
4	0.000911
5	0.001171
6	0.0032
7	0.0036
8	0.0040
9	0.0043
10	0.0046
11	0.0049
12	0.0051
13	0.0053

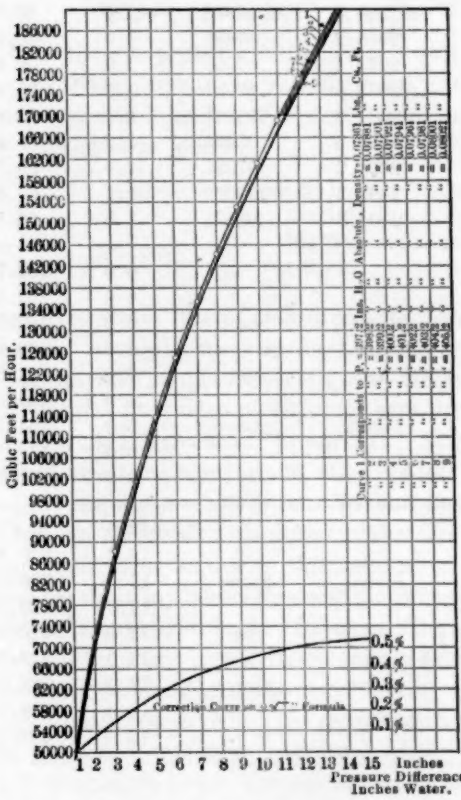

FIG. 2 THEORETICAL CURVES OF VARIATION IN FLOW THROUGH THE VENTURI METER

COMPUTED IN CU. FT. PER HOUR WITH VARIATION IN PRESSURE DIFFERENCE, $p_1 - p_2$ IN INCHES H_2O FOR DIFFERENT DENSITIES OF THE GAS WHERE p_1 IS THE PRESSURE AT "UPSTREAM" PIPE, HAVING A DIAM. OF 15¼", AND p_2 IS THE PRESSURE AT "THROAT," HAVING A DIAM. OF 6¼"

The cubic feet of gas per hour from the throat velocity head increment was computed by the formula for 1 inch, 6 inches, and 12 inches and by the proportionality to square root with the above correction for all other points. The three calculated results are given in the following table and the curves for all points are plotted in the curves on Fig. 2:

GAS PRESSURE						
Ins. water above atmos.	Ins. water absolute	Lbs. per sq. ft.	Lbs. per cu. ft. of gas	Increase in vel. head due to throat in ins. water	Vel. of gas at throat ft. per second	Cu. ft. of gas per hour
—1	397.2	2063.0	.07861	1.0	66.218	50,791
0	398.2	2068.2	.07881	1.0	66.127	50,732
1	399.2	2073.4	.07901	1.0	66.062	50,671
2	400.2	2078.6	.07921	1.0	65.939	50,516
3	401.2	2083.8	.07941	1.0	65.888	50,536
4	402.2	2089.0	.07961	1.0	65.782	04,565
5	403.2	2094.2	.07981	1.0	65.719	50,409
6	404.2	2099.4	.08001	1.0	65.598	50,312
7	405.2	2104.6	.08021	1.0	65.533	50,265
—1				6.0	162.717	124,807
0				6.0	162.494	124,635
1	Same	Same	Same	6.0	162.307	124,492
2				6.0	162.080	124,320
3	as	as	as	6.0	161.870	124,157
4				6.0	161.691	124,008
5	above	above	above	6.0	161.521	123,888
6				6.0	161.303	123,722
7				6.0	161.070	123,543
—1				12.0	230.709	176,957
0				12.0	230.315	176,655
1	Same	Same	Same	12.0	230.052	176,451
2				12.0	229.776	176,241
3	as	as	as	12.0	229.486	176,019
4				12.0	229.229	175,822
5	above	above	above	12.0	228.911	175,579
6				12.0	228.616	175,352
7				12.0	228.327	175,130

4 From these preliminary conclusions the data are ready for the test results. A characteristic set of possibilities is given in the following table:

GAS

VENTURI METER

Run No. 1				Run No. 2				Run No. 3			
Time	P_1-P_2	P_3	P_1-P_3	Time	P_1-P_2	P_3	P_1-P_3	Time	P_1-P_2	P_3	P_1-P_3
	13.0	4.4	2.8		11.0	4.3	2.55	4.25	10.0	4.4	2.35
2.25	13.0	4.5	2.7	3.25	11.0	5.0		to	9.75	4.2	
to	12.5	3.5		to	11.2	4.8		4.50		4.6	
3.15		4.0		4.20		3.8		p.m.		3.8	
p.m.		4.9				4.5					
		4.6				2.6					
		5.0				2.7					

All pressures in inches of water

Run	P_1-P_2	P_3	P_1-P_3	P_1
1	12.9	4.55	2.75	7.30
2	11.04	4.06	2.55	6.61
3	9.88	4.25	2.35	6.60

In the above, P_1 is the gas pressure in inches of water above atmosphere, and $P_1 - P_2$ is the increase in velocity head due to the throat contraction measured also in inches of water. Applying these to the curves, the gas works out as follows:

Run	Cubic feet of gas per hour by Venturi
1	183,640
2	169,360
3	160,120

5 It was believed from these measurements that the Venturi meter was the most accurate method used, and it is freely recommended to all who have large quantities of gas to measure, even when the pressure on that gas fluctuates as violently as it may with a number of gas engines on the pipe, running in parallel. Since the time the previous reports of the tests were made, the Builders Iron Foundry made for me at my request a series of four Venturi meters in pairs of two, 1 and 2 inches in diameter with different throat ratios, for some determination of their value as devices for measuring steam. These meters have been set up in my laboratory and a number of tests made. In order that the meters may be checked for measuring steam, a Foster steam superheater is arranged in the steam supply to give any degree of superheat, and it is assumed that the steam is just dry when about one degree of superheat is observed. The results of these tests are not yet ready to be published, but it appears from what has been shown so far that it will be possible to use Venturi meters on steam lines. It may be that they will not be of great value to determine the weight of steam flowing in any line, but they certainly will give very valuable information on the per cent of the total steam generated in a header

and distributed from a header to each of the branches. If in a power plant the amount of steam flowing into the various branches be known as a proper fraction of the total, then it will be possible to charge the cost of operating whatever is supplied by that branch. In conclusion, I would like to say that I believe Venturi meters for steam work and gas work, especially in large sizes, are useful and their use should be encouraged.

TEST OF A PLUNGER ELEVATOR PLANT

By A. J. Herschmann, Published in November Proceedings

Mr. R. P. Bolton There are several points in Mr. Herschmann's paper to which amendment should be applied.

2 No statement is made as to the number of short run elevators. I believe there are five, operated as way-cars to the eleventh floor.

3 Inasmuch as the main object of the test was the establishment of the economy of the elevator operation, an explanation would be desirable as to why the larger boiler was selected for the smaller load. (pp. 417–418) The tests recorded, bearing on other parts of the plant, do not appear to have any relation to the subject matter of the paper, and are not referred to, nor are any of the conditions explained in the text.

4 I suggest they should be transferred to the end, or to p. 418, as they prevent direct comparison between the two comparative tests with which the paper is concerned and which would be more conveniently arranged together.

5 (pp. 417–418) Items in tests, No. 17 should follow No. 13; No. 18 has no bearing on boiler results.

6 (p. 420) The results hereon are confusing in their present form, and are not placed in the order of the loads carried.

7 Explanation is needed of the load carried in test of locals 8, 9, and 10, which appears to be composed of four men, in addition to 653.5 pounds of dead weight.

8 (pp. 421–422) Items 8 and 25 are duplicates; items 12, 13, and 20 need explanation; 12 and 13 on p. 421 do not appear to include boiler-feed. The same items on p. 422, No. 12 does include boiler-feed, but No. 13 does not. How is No. 20 ascertained? Item 32: Why should a round number be given?

9 The last item (p. 423), I believe, should read: "Total net rentable area on 22 floors."

10 As to the subject matter of the paper, that is, the trials giving the ascertained results of coal consumption, car travel and passenger

load, I have to say: I cannot agree with the author that such a form of trial has the value which would be afforded by a definite test with an ascertained load in the traveling machine, nor, with the estimated elements introduced, that it can be reliably depended upon to decide or compare with results in other buildings. Item 5: I cannot see how this statement of saving is borne out, as by comparison of items 16 and 36 (p. 422), we find that there was actually pumped 81,920 cubic feet while the ram travel recorded required only 77,496 cubic feet, leaving a discrepancy (or waste of water through valves or by leakage) of 4424 cubic feet. If, however, the over-run draws in 5 per cent more than the amount actually required, the ram travel contents would be 77,496, less 5 per cent or 75,622 net, leaving to be charged to valve operation or leakage as much as 8298 cubic feet, or over 10 per cent of the total amount pumped.

11 The results reported in this paper aim to establish a direct comparison between the two types of pumps, to the advantage of the high duty fly-wheel pattern, by 35 per cent less fuel per car mile of elevator travel; But this does not seem to take into account the fact that the average load lifted was different in the two cases, and still leaves unexplained the unusual results reported with the direct acting duplex compound pump.

12 The load directly affects the traveling speed and, therefore, the mileage attainable within a given time is dependent upon it, and the method of comparison by car mileage is entirely misleading, unless the load which is carried be ascertained and stated.

13 The averages on these tests, at 140 pounds per person, including operator, are, for duplex trial, 511 pounds, and for the fly-wheel trial, 564 pounds in addition of 10 per cent to the load lifted by the duplex pump.

14 In the comprehensive test, which I conducted at the R. H. Macy Company's plant (Transactions 24, No. 0977, 1903), the cars carried a fixed load of 1000 pounds, with which the mileage recorded was attained.

15 The dynamic work, therefore, included in these two trials is but from 51 to 57 per cent of the Macy test, and the best stated consumption of coal is somewhat greater. The same (fly-wheel) type of pump, and of water tube boiler was used in the Macy test, the elevators being of standard hydraulic pattern with gear of 6 to 1.

16 The results when compared with the statements of this paper are as follows:

	Trinity Bldg.	Macy Bldg.
Fuel per car-mile	34.4	32.32
Steam per car-mile	252.8	231.5
Live load per car-mile	1,107,700 ft. lbs.	2,640,000 ft. lbs.
Live load per pound of fuel	32,137 ft. lbs.	81,370 ft. lbs.
Efficiency of work, related to thermal value of fuel	.034 per cent.	.080 per cent.

17 It will thus appear to be clear that the attempt to operate the plunger system at high speeds is accompanied by a considerable loss of efficiency. That this is to be expected is shown by the results of a comparison of an ordinary hydraulic passenger cylinder proportions with those of the express plungers described in the paper.

18 A speed of 518 feet with 840 pounds live load requires with a plunger, 6½ inches diameter, a pressure of 185 pounds per square inch. A speed of 600 feet, with 840 pounds live load, requires with a 16 inch cylinder and gear of 6 to 1, a pressure of 150 pounds per square inch.

19 Mr. Matthews has dealt with the really vital question in connection with the express elevators, described in the paper which is that of the extensive distance required for a stop in the up-run, and the necessary addition to the unbalanced load which is required to reduce that distance, at the same time affecting adversely the economy of operation.

20 The main difficulty with this type of machine is that at high speeds the unbalanced load must necessarily be increased to provide for a stop of the car within a safe distance, which standard practice has limited to a space of about eight feet.

21 The five express machines described in the paper are arranged with working parts of the weights, given on p. 423, so as to have an unbalanced weight of 2001 pounds. At a speed of 600 feet per minute, which, with a light load can be readily expected (under a pressure of 185 pounds and with about 600 pounds load) the gravity stop will require a space of 18½ feet.

22 To bring about a gravity stop within a distance of 12 feet, which is about the average space between office building floors, the unbalanced load should amount to 2241 pounds.

23 To bring about a gravity stop in the recognized safe space of 8¼ feet, the unbalanced load would be increased to 4611 pounds. This would then involve a working pressure at the pump of 220 pounds per square inch.

24 The loss of efficiency being larger in the high run, which are the express machines, it would have been of interest to learn the com-

parative water and fuel consumption of the two sections of the elevator apparatus. The express plunger machines are therefore being operated at their present economy at the expense of a safe stopping control on the up-run with light loads. Plungers of this length are subject to peculiar conditions as regards the nature of the support of the plunger itself.

25 Thus, in the long run of 283 feet, the plunger is in part hanging from the car, and only the following portions stand supported on the water in the cylinder:

At top of run with car empty,	69 feet standing,	214 feet hanging.
At top of run with car full,	176 " "	107 " "
At half of run with car full,	138 " "	3 " "

to which peculiar combination is due the swaying of the neutral point in the plunger.

26 Such conditions are favorably modified, and other unfavorable features may be eliminated, when the plunger is of moderate length, and of larger diameter.

27 In conclusion, I desire to be distinctly understood as appreciating the general merits of the plunger type under those conditions of proper proportion of ram diameter to length and speed, and I have demonstrated that appreciation by having been the first engineer to adopt the plunger machine in New York City.

28 Finally, as a general proposition, I desire to impress upon you that the method of comparison of elevator operation by mere statement of car travel is all wrong. It is a case of the ingenious working of the devil around a stump. A car-mile run by an empty train is not to be compared to a car-mile run by a fully loaded train, and as the speed of all elevators varies according to their load, a heavily laden machine does not make the car-mile distance that a lightly loaded car will; and we should in any further tests have weights ascertained and stated.

29 I trust this discussion will have one important result, namely, to draw the attention of those responsible to the desirability of proportioning the plunger size to speed and travel. If that is attained, this paper, though in my judgment of no value as a record of operating conditions, will have accomplished a result of much general advantage.

Mr. W. Y. Lewis The title of this paper should have included some reference to the pumps so remarkably compared in the results given and perhaps the paper should have been entitled "The Influence of the Power Plant Design upon Elevator Operating Costs." Com-

paring the results with the data given in Mr. Pratt's paper on the Park Row Elevator Tests, one might conclude that electric elevators are far superior to the hydraulic plunger type, but this I believe is contrary to general opinion and actual fact. It shows, however, that the author's assumption, "That the plan adopted for the test would readily enable serviceable comparisons to be made with other tests," was quite unwarranted. I think the Society should draw up some regulations on a definite plan for the conduct of future elevator tests.

2 The point I wish to bring into view is that notwithstanding the great speed and large number of elevators, the time interval between both local and express cars is about 39 seconds so that the average time a person has to wait for a car is 20 seconds. If this time is taken into account, the average time of a journey to any floor is considerably less than what one might imagine when such high elevator speeds are talked so much about.

3 In a continuous elevator the car intervals could be reduced to four or five seconds and it would give 40 per cent more capacity than the elevator described, in only 25 per cent of the space, so that the saving in rentable area would be enormous. I am very much surprised that up to the present nothing has been done in this country with continuous elevators, and would call the attention of architects and elevator engineers to the subject, as there are great advantages over the present intermittent service elevator systems lying dormant in the continuous elevator proposition.

A HIGH DUTY AIR COMPRESSOR

By O. P. Hood, Published in November Proceedings

Mr. F. V. Henshaw As affecting commercial results, new economies in the boiler plant look to me more possible of realization than equivalent economies to be derived from further improvements in engine design. It seems to be characteristic of the attitude of many mechanical engineers to devote much time to questions relating to engine efficiency while rather neglecting those relating to the efficiency of the rest of the plant, though the efficiency of the engine itself appears to be much nearer to the attainable ideal than is the case with furnaces and boilers. It appears to me that our existing boiler plants offer most encouraging possibilities of reductions in cost of steam power.

2 In regard to separation of oil from exhaust steam I would say that, while the situation looks bad for mechanical separation, I do not think it well to be too sure of its impossibility. Incidentally, I am

informed that there is a plant in Long Island City where oil is being separated under a guarantee with something like $5 penalty per drop of oil in feed water.

Mr. Sanford A. Moss I presume that the volumetric efficiency has been computed from the distance between admission and clearance expansion points on the indicator card. As is well known, volumetric efficiency computed on such a basis ignores heating of the air at the beginning of compression, and piston and valve leakage. There are many causes which may contribute to make the temperature of the air at the beginning of compression much higher than the temperature of the air in the suction pipe. It is, of course, evident that piston and valve leakage may also exist to a considerable degree and not be noticeable. Hence in spite of the fact that it is the custom of years to measure volumetric efficiency according to the method used by the author, there is no certainty that the method is at all correct. The only reliable method would be to actually measure the quantity of air by use of orifices, Pitot tubes, Venturi meters, or some similar method, as discussed in Mr. Coleman's paper, "The Flow of the Fluids in a Venturi Tube," or in "The American Machinist," Sept. 20 and 27.

2 I have had some slight experience in actual measurement of volumetric efficiency and have found enormous discrepancies as compared with indicator card volumetric efficiency, principally owing to piston leakage. Personally, I am of the opinion that the average reciprocating compressor loses a surprisingly large amount of air in this way. I know of no published tests of a reciprocating compressor in which the quantity of air has been actually measured. Possibly some members have some information as to this point. A discussion of it would certainly be important.

3 Measurements of quantities of air by use of orifices, Venturi meters, Pitot tubes, etc., are often held in bad repute. There is no reason for this, however, and results to any required degree of accuracy may be readily obtained.

4 Possibly one reason for the poor opinion commonly held regarding such measurements is because of the great difference between quantities of air measured by such means and actual piston displacement. If such differences are found, they are due to inefficiency of compressor, however, and not to errors in the quantity measurement.

Mr. W. Y. Lewis It is to be regretted that the paper treats only of thermodynamics, because as everything in engineering is a question

of dollars and cents it would have been of much more valuable interest if details of costs including interest and depreciation per undivided horse power hour had been given. The author states that owing to the high cost of fuel, managers in the district have been led to install the highly efficient plant described but the records given are not sufficient to enable one to judge whether or not the expenditure is justified. One is bound to ask at what expense this result was attained, over and above the necessary capital outlay for a more ordinary plant using superheated steam, and then make comparison to see if the saving in operating cost would be enough to warrant the increased outlay, and cover the many practical disadvantages arising from the use of such a high boiler pressure and the running of such a very complicated plant.

2 It seems to me a better all round result might have been attained if the engine had been compound with a total of four cylinders instead of quadruple with eight cylinders. In the matter of mechanical efficiency there would surely be an improvement. Some years ago Messrs. Hick-Hargreaves of Bolton, England, made very thorough investigation as to the relative value of compound and triple engines from the friction point of view, and the following is an example of the result they invariably found. A set of 1300 horse power mill engines of the two cylinder compound type showed a loss by friction of 5.85 per cent while a set of 1600 horse power three cylinder triple expansion engines showed a loss of 8.8 per cent. In this case a steam consumption of 12 pounds per horse power hour in the compound would be equally as efficient as 11.62 pounds in the triple, as each would require 12.74 pounds per brake horse power hour. The inference to be drawn from this is that a compound design would have been superior to the quadruple set forth by the author, especially as there are the air cylinders to be considered in addition to the steam.

3 Ten years ago there was much discussion among English mill engine builders as to the extent to which steam pressure might be advantageously raised with the consequent adoption of multiple cylinders. A number of triple and a few quadruple engines were put down, but for the last seven or eight years there has prevailed an increasing tendency toward compound engines working at 150 to 160 pounds, even for 1800 and 2000 horse power capacities, as experience has shown that, while they have great advantages in point of simplicity and reliability, they can compete very closely in thermal efficiency, being actually the least expensive and most satisfactory type of engine to use.

4 Superheating is of course being very generally adopted with

the certainty of reducing losses caused by cylinder condensation, the reduction of which was the one excuse for multiplying the stages of expansion. It is surprising to me that the builders of the engine described did not take this line instead of the troublesome high boiler pressure, and the rather cumbersome total of eight cylinders. Surely it is the marine engine, where the usual valve gear employed unfortunately allows of only a limited number of expansions, that alone calls for quadruple cylinders.

5 It seems to me that there is no particular virtue in four air cylinders instead of two, anyhow it does not account for the remarkably high volumetric efficiency given as 98 per cent. This surely must be an error in view of the percentage clearances given, from which I should think the volumetric efficiency would prove to be nearer 90 per cent. Inspection of the air cards indicates other doubtful points, all tending to upset the figures given for the efficiency compared with isothermal compression. Special tests indicating such wonderful efficiencies as are given in the paper are always very doubtful.

6 Referring to the auxiliaries, I certainly do not like the arrangement of operating eleven pumps by one single crank, as any serious defect in any one of them might put the whole engine out of business—and the layout of all these important items under the floor, probably in a cramped space, doubtless leaves much to be desired. The horse power indicated for the auxiliaries appears to be extremely small, and it is to be regretted that the power absorbed by them in the indicated horse power divided into the steam consumption was included, as it is not general to do this in testing power house plants where the auxiliaries are more properly independently driven. I would like to point out that according to the result of steam consumption per indicated horse power given, the horse power of auxiliaries was delivered at 25 per cent thermal efficiency, whereas if they had been separately driven by independent steam engines exhausting into open type feed water heaters, their thermal efficiency would have been about 80 per cent. Mr. Stott in his recent paper before the American Society of Electrical Engineers on the 59th St. Power Station of the New York Interborough Co. elucidated this point and I would again call attention to it as it is not generally recognized, moreover, it is a very strong argument against the use of electric motors for driving auxiliaries.

7 Some information about the boiler difficulties met with above 250 pounds pressure would be interesting. I note the boilers were fed from the hot well and that some kind of oil separators were used—a description of which would be desirable. There seems to be a general impression that, if oil be admitted to water tube boilers,

burnt out tubes would soon result. I may be excused for digressing from the subject of this paper in stating my own experience on this point in the hope that it may prove useful to those who are inclined to use jet condensers in fear of boiler troubles arising from the use of hot well water provided by surface condensers. Pure mineral cylinder oil does no harm to boiler tubes, even if quite a considerable quantity gets in with the feed water, provided there is practically no lime present at the same time. If a compounded cylinder oil has to be used on account of wet steam supply to cylinders, then great care must be taken to extract it, otherwise its 10 per cent animal fat will cause it to stick to the tubes and cause burnouts. I have yet to be convinced that oil can be successfully extracted by any straight mechanical means. A combined chemical mechanical plant is necessary and the only apparatus I have confidence in after some fourteen years experience in this problem is the one employing alumina ferrie, which turns the saponified oil into an insoluble soap then held in fine suspension by the water from which it is easily extracted by a sand filter. I have used this arrangement with success in three large power plants and would be happy to furnish any further information members may desire.

8 I think it regrettable that engine builders do not pay more attention to the balancing problem, which is of considerable importance in the four crank engine described, though presumably it has been overlooked. Apparently, there are large unbalanced forces and couples having their own free will on the bearings and foundations of this engine, and I feel sure the judicious application of Professor Dalby's beautifully clear vector and semigraphical method of solving the problem would be attended by gratifying results.

9 Professor Hood has prepared a very interesting, if not altogether practical study in thermodynamics, and while the builders of the engine, are to be congratulated on the results said to have been attained, I feel sure that if in line with other builders, they would devote their attention to the more simple and practical compound-engine compressor using superheated steam and having independent auxiliaries, they would be doing the engineering world at large, and particularly those who are often in the market, a far greater service than by specializing in such extremes as the paper indicates.

BOILER AND SETTING

By A. Bement, Published in November Proceedings

Professor Jacobus Mr. Bryan has brought out a number of points on which I intended to speak. All authorities agree that with

the proper arrangement of heated brick work and a long enough pass for the gases in the furnace, much can be done in stopping the smoke; but to be efficient, the brick work must be brought to a high temperature, and eventually it will deteriorate and have to be replaced. In some cases the cost of maintaining the brick work may outweigh the increase in the economy through its use, whereas in others the increase in economy may far outweigh the cost of maintenance. In any case, the cost of replacing the brick work is apparent to the user of the boiler, and sometimes he may be hampered in having to throw out the boiler for repairs during a busy season, whereas the gain in economy through using the heated brick work, being distributed over a long interval of time, is not so apparent, and he may therefore be misled into considering that what in reality was an economical arrangement was an unprofitable one.

2 The problem of smoke consumption in a large plant where firemen of various grades of intelligence must be employed, and where it is necessary at times to quickly increase the capacity and in some cases to run with a considerable overload, possesses far greater difficulties than that of the small plant which is run well within its capacity and where expert attendance is available. It is in preventing the formation of a light smoke at certain periods, and the throwing off of the heavier smoke when the boilers are forced, that many of the so-called smoke consuming devices fail.

3 For volatile western coal, the Babcock & Wilcox Co. make use of an extension furnace similar to the one which Mr. Bement shows at the front of the boiler, but instead of passing the gases to the back of the boiler and then forward, as shown in Mr. Bement's plan, they are passed through the boiler in the ordinary way, that is, first upward through the front or first pass, then downward through the middle pass, and finally upward through the last pass. With this arrangement, there is less loss of draft in passing the gases through the boiler, and the tubes next to the lower rows do not have to be removed in order to allow for blowing out any dust which may collect, as is done in the setting recommended by Mr. Bement. Any dust deposited in the setting just described will collect in the space back of the bridge wall from which location it can readily be removed. The arch over the extension furnace is extended a short distance under the boiler, and with a chain grate stoker there is no smoke.

4 In the marine type of the Babcock & Wilcox boiler, or what in stationary work is called the semi-marine type, a chain grate stoker may be placed directly under the boiler and the gases made to pass beneath a long arch which ascends from front to rear, and all the

advantages of an extension furnace may be secured with a saving in floor space.

5 In the discussion by Mr. Ennis, an account is given of some tests with Babcock & Wilcox boilers with oil fuel where these boilers were found to be less efficient than horizontal return tubular boilers.

6 The figures given should not be regarded as a basis for comparing the efficiencies of the two types of boilers when using oil as fuel, because with the proper furnace for oil burning, the Babcock & Wilcox boilers give an efficiency equal to that which Mr. Ennis found for the horizontal return tubular boilers, or 80 per cent. This efficiency has been reached in many tests in San Francisco and elsewhere. In tests made at Los Angeles where these boilers were fitted with the Peabody Oil Furnace and where comparative tests were made, the results being checked by a disinterested engineer, as high as 83 per cent of efficiency was obtained. The day is passed when a particularly high efficiency can be claimed for any special type of boiler. With an efficient furnace and the proper amount of heating surface so arranged that the hot gases circulate properly over it, all good boilers will have nearly the same efficiency.

Mr. E. A. Hitchcock Mr. Bement states that the principal objects to be secured in the design of setting as set forth is, first: the attainment of perfect and smokeless combustion, and, second: the full utilization of the boiler heating surface. As regards the first point, my experience with Hocking Valley pea and slack coal on boilers of the horizontal water tube type, 3½-inch tubes, with enveloping tile forming a refractory roof, in conjunction with inclined grate automatic stokers, has been the obtaining of very nearly smokeless combustion, and as to perfect combustion, the products at times would contain CO, but not sufficient to make the loss in this direction more than one-half of one per cent.

2 As regards the second point, there is something quite important which must be taken into consideration at time of installation, if this form of setting is to be used. The form of baffling as shown by Fig. 1 may add materially to the efficiency of the heating surface above the lower row of tubes, but on the other hand, the enveloping tile has cut down very materially the large amount of work the lower row is capable of doing on account of practically no radiant heat effect. For example, I have found in the type of boiler spoken of above, containing 4880 square feet of heating surface and rated at 450 horse power, that it was impossible to get the boiler rating with anywhere near reasonable flue temperatures, tube surfaces both inside and out

and tiling being in good condition. Observations covering a period of 24 hours would give an average horse power of 334 with a maximum of 374 while the average flue temperature was 705 degrees F. with a rate of combustion for the pea and slack coal of only 18 pounds per square foot of grate per hour, the ratio of grate to heating surface being 1 to 54.

3 The effect of the enveloping tile in this same direction is well shown in the first report of the U. S. Fuel Testing Plant at St. Louis. The builders' rated horse power for the boiler used was 210 with a ratio of grate to heating surface of 1 to 50.1. The average horse power developed for 70 of the trials given is 195.7 while the average flue temperature of the same series is 578 degrees F., therefore, if we are to use the form of setting under discussion and maintain good efficiency, at the same time obtaining the usual capacities, a much larger number of square feet of heating surface per horse power must be allowed than has been customary, with also an increase of ratio of grate to heating surface.

STEAM TURBINE CHARACTERISTICS

By Hans Holzwarth, Published in November Proceedings

Capt. H. Riall Sankey, R. E. (ret.) In paragraph 7 of the paper the term "total efficiency" is used to express the ratio between the amount of available energy and the amount of accomplished mechanical energy. Personally, I much prefer the term "Efficiency Ratio" recommended for this purpose by the Thermal Efficiency Committee of the Institution of Civil Engineers (London).

2 Mr. Holzwarth makes great use of graphic methods, by the aid of charts prepared for the purpose. A somewhat differently designed chart may, therefore, be of interest, and I publish a copy herewith. I have reproduced the example given by Mr. Holzwarth in paragraph 55. *A* is the initial point of the steam, namely, at 10 atmospheres or say 150 pounds per square inch. *AB* is drawn, vertically *i.e.*, adiabatically, and is the expansion line of the Rankine engine. *B* is the exhaust point at a pressure of 0.1 atmosphere or say 1.5 pounds per square inch. From the chart it will be seen that the total heat at *A* is 1192 B. t. u. and *B* 890. Hence the Rankine engine converts 302 B. t. u. into work per pound of steam. This is equavalent to 167.6 calories per kilogram, practically the figure given by Mr. Holzwarth. These heat quantities are read off the chart by means of the constant heat lines and the heat scales.

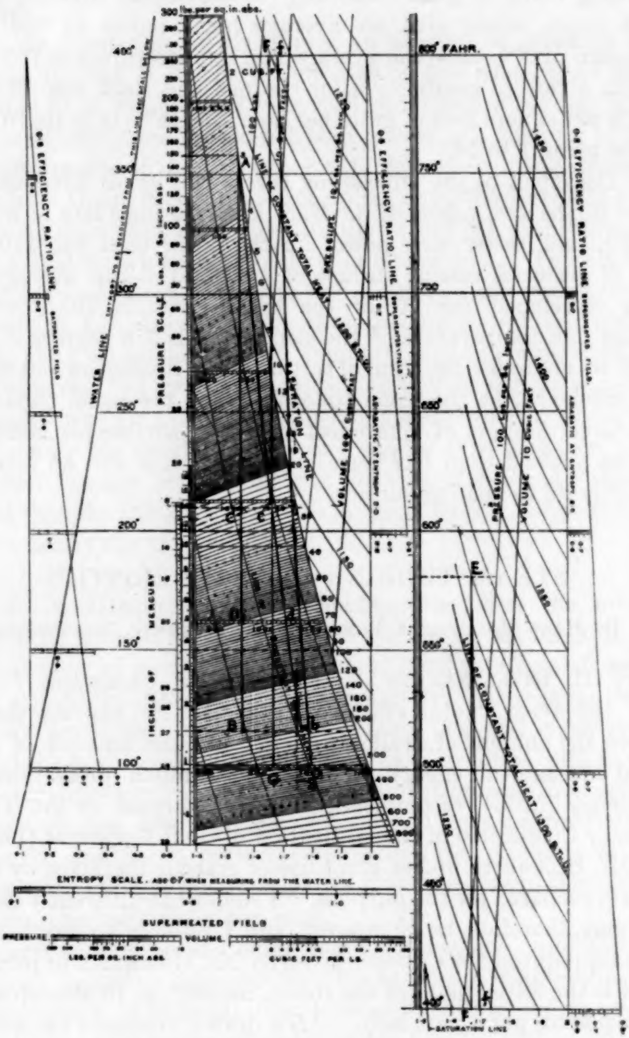

FIG. 1 ENERGY CHART FOR USE WITH STEAM TURBINES

3 It will be further observed that at the initial point the volume of the steam is 2.97 cubic feet per pound, and that at the exhaust point it is 180 cubic feet. Hence the steam is expanded 60.6 times.

4 Suppose we are dealing with an actual turbine whose efficiency ratio is 60 per cent, then the expansion line of this turbine is obtained

by drawing through A a line Ab parallel to the line marked "Efficiency ratio line" on the chart. This is the expansion line of the actual turbine, and it will be seen that the volume at the exhaust point is 201 cubic feet, so that the steam expands 201/2.97 or 67.7 times. The total heat, as read off the chart, is 1004 B. t. u. so that $1192 - 1004 =$ 188 B. t. u. have been converted into work. Since the Rankine engine converts 302 B. t. u. into work, the efficiency ratio of the turbine is $188/302 = 0.62$, which is practically the figure on which Ab was based. The slope of the lines marked "Efficiency ratio" on the chart varies slightly with varying conditions, but so very slightly that an average position has been taken, as sufficiently accurate for practical purposes.

5 If $c\,d$ is a "stage" in the turbine from 14 to 5 pounds pressure per square inch (see the vertical pressure scale on the chart) it will be seen that the heat at c is 1085 and at d 1046 B.t.u. so that the conversion into work in this stage in 39 B.t.u. The corresponding points on the Rankine expansion line are C and D; at these points the heat values read off the chart are 1020 and 956, showing a conversion of 64 B.t.u. The "stage efficiency ratio" is therefore 39/64 = 0.61, as before. The lines relating to this example are shown at $B\,D\,C$, A, $c\,d\,b$.

6 I have also taken another example in which I have assumed: Initial steam 200 pounds per square inch abscissa with 200 degrees Fahrenheit, superheat or total temperature of 582 degrees Fahrenheit. Pressure at exhausting point one pound per square inch abscissa. Efficiency ratio: 0.80. The initial point E of the steam on the chart is found by measuring the distance taken off the pressure scale for the superheated field between 200 and 100 pounds per square inch, and plotting this distance to the left of the 100 pound constant pressure line at the temperature horizontal for 582 degrees Fahrenheit. EFG is drawn adiabatically, and Efg is drawn parallel to the 0.80 efficiency ratio line, using the appropriate scales for each part of the chart. The former is the expansion line of the Rankine engine, and the latter the expansion line of the actual turbine. It will be seen that the total heat at E is 1320 B.t.u., at G it is 928, and at g it is 1005. Hence the heat conversions are 392 and 315, respectively. The efficiency ratio is $315/392 = 0.805$, this is a check on the drawing.

7 The volume at the initial point measured on the volume scale for the superheated field is 3.05 cubic feet, and the volume at the exhausting point is 290 cubic feet for the Rankine engine, and 310 for the turbine. The respective expansions are therefore 95.2 and 100.6

8 The feed water per horse power hour can in all cases be determined by dividing the B.t.u. converted into work into the constant 2545.

Hence	Rankine Engine	Actual Turbine	Equivalent Feed for Actual Turbine
First example	8.5	14.1	14.2
Second example	6.5	8.1	9.2

9 The "equivalent feed" is the feed reduced to the standard of 1100 B.t.u. per pound of steam, that is the heat required to produce a pound of standard steam. This was recommended by the Engine and Boiler Committee of the Institution of Civil Engineers. In the first example the heat required to make one pound of steam starting from the exhaust temperature (116 degrees Fahrenheit is $1192-84=1108$. Hence the equivalent feed is $14.1\,\frac{1108}{1100}=14.2$. In the second example the heat required is $1320-68=1252$, and it will be found that the equivalent feed is 9.2.

Mr. A. Bantlin I am of the opinion that the logarithmic $p-v$ diagrams, as proposed by Mr. Holzwarth, are very well adapted for many applications, viz: In the first curve of steam turbines, to obtain quickly and simply an insight into the relations of p to v in each stage; into the distribution of work in each, as well as the determination of certain principal maesurements of the steam turbine by means of simple calculations. In the examination of completed steam turbines to determine irregularities in the course of expansion and in the distribution of work upon each stage, when the pressures upon the same have been measured.

2 The influence of any change in the steam pressure upon the economy of the steam turbine may also be deduced very plainly from the diagram.

3 Attention may also be called to the great facility furnished in drafting logarithmic abscissæ and ordinates by the aid of the slide rule as well as in the simple registration of the rectilinear expansion lines for wet, saturated, or superheated steam.

I do not doubt, therefore, that the logarithmic $p-v$ diagrams will be welcomed as a simple and valuable expedient.

FERROINCLAVE ROOF CONSTRUCTION

BY A. E. BROWN, PUBLISHED IN OCTOBER PROCEEDINGS

MR. B. N. BUMP Referring to Mr. Brown's paper on "Ferroinclave Roof Construction," I would like to ask Mr. Brown, if he has examined a section of the roof after it has been in service for several years. Not more than two years ago, a roof of such construction as Mr. Brown describes was put on a machine shop. A short time ago a heavy weight fell from above and broke through that roof, and on examination we found that the concrete or the sand and cement was in very good condition, but the iron was represented by a streak of rust only.

2 This leads us to wonder what is going to be the outcome of other steel concrete construction, which is being used to a considerable extent.